REPORT

ON THE

IMPERIAL MYCOLOGICAL
5 OCT. 1931
INSTITUTE

DEPARTMENT

OF

SCIENCE AND AGRICULTURE

BARBADOS

FOR THE YEAR

1930-31.

ADVOCATE CO., LTD.,
Printers and Book-binders to the Government of Barbados.
1931.

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BOARD OF AGRICULTURE,

DEPARTMENT OF AGRICULTURE,

BARBADOS.

July 31st, 1931

Sir,

I have the honour, by direction of the Board of Agriculture, to transmit the Report on the Department of Science and Agriculture for the financial year 1930—31.

2. I trust that it may be possible to print and publish this Report at an early date.

I have the honour to be,

Sir,

Your most obedient servant,

S. C. THORNE,

Chairman of the Board of Agriculture.

The Honourable
The Colonial Secretary,
Public Buildings.

No. 116/965.

DEPARTMENT OF AGRICULTURE,

BARBADOS.

July 31st, 1931.

Sir,

I have the honour to submit to the Board of Agriculture a Report on the work of the Department of Science and Agriculture for the year 1930—31.

I have the honour to be,

Sir,

Your most obedient servant,

R. W. R. MILLER,

Director of Science and Agriculture.

S. C. THORNE, Esq.,
Chairman of the Board of Agriculture.

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Chapter I.

REPORT OF DIRECTOR OF SCIENCE AND AGRICULTURE.

SECTION I.—STAFF.

Director of Science and Agriculture	R. W. R. Miller, B.A., (Camb.), A.I.C., Dip. Agric. (Cantab).
Assistant Director	C. C. Skeete, B.A. (Cantab).
Geneticist	A. E. S. McIntosh, B.Sc., Ph.D., (Edin).
Agricultural Chemist	S. J. Saint, B.Sc., (London), A.I.C.
Assistant to Professor of Chemistry..	T. A. E. Barker, B.Sc., (London).
Lecturer in Natural and Agricultural Sciences	Vacant.
Entomologist	R. W. E. Tucker, M.A. (Cantab), B.Ed. (Capetown).
Veterinary Officer	Lt. Col. H. Greenfield, M.R.C.V.S.
	A. E. C. Goodman, D.V.S. (Acting)
	C. P. Stoute, M.D.V. (Acting).
Chief Analytical Assistant	C. A. Coppin, B.A.Sc. (Toronto).
Plant Diseases Inspector	D. R. D. Wiles, D.I.C.T.A.
Chief Clerk	H. O. Ramsey.
Second Clerk	G. D. Ramsey.
Third Clerk	C. G. Humphrey.
Fourth Clerk	B. G. Barrow.
First Field Assistant	C. B. Foster.
Second Field Assistant	H. E. Ward.
Third Field Assistant	C. C. Corbin.
Fourth Field Assistant	F. E. Bynoe.
Analytical Assistant	H. A. Jones.
„ „	C. St. A. Alleyne.
„ „	L. A. Hall.
Botanical Assistant	L. H. Atkinson.
Foreman in Charge of Nurseries ..	S. A. Eastmond.

Mr. R. W. R. Miller was absent on duty leave in Trinidad from April 18th—22nd attending a meeting of the Standing Committee of the West Indian Agricultural Conference.

Mr. C. C. Skeete resumed duty after vacation leave on September 18th.

Mr. R. W. E. Tucker was granted vacation leave from March 13th to March 26th, 1931.

Mr. S. J. Saint proceeded on vacation leave from April 22nd.

Dr. A. E. S. McIntosh proceeded on vacation leave from June 2nd.

Lt. Col. Greenfield was granted an extension of leave to September 23rd, 1930. During his absence from the colony, Dr. A. E. C. Goodman undertook to perform the duties of Veterinary Officer. Lt. Col. Greenfield resigned on September 23rd and Dr. C. P. Stoute was appointed to act.

The post of Lecturer in Natural and Agricultural Sciences remained vacant throughout the year.

Mr. C. A. Coppin was granted five and a half months' vacation leave from November 4th, 1930. He resumed duty on April 19th, 1931.

Mr. C. B. Foster was granted twenty-six days vacation leave from January 6th—30th, 1931.

Mr. S. H. Evelyn resigned the office of Third Field Assistant on July 22nd, 1930, and Mr. H. E. Ward was appointed in his place on October 1st, 1930.

Mr. Ward was promoted Second Field Assistant on March 11th, 1931, and Mr. C. C. Corbin was appointed in his place on April 1st.

Mr. F. E. Bynoe was appointed Fourth Field Assistant on May 6th, 1930.

Mr. L. H. Atkinson was appointed Botanical Assistant on April 1st, 1931.

SECTION II.—BOARD OF AGRICULTURE.

The members of the Board of Agriculture, appointed for the Legislative Session, 1930—31, were as follows:—

The Honourable G. L. Pile, B.A., M.L.C., Chairman.
" " W. B. H. Massiah, M.A., M.D., C.M., M.L.C.
S. C. Thorne, Esq., M.C.P.
G. C. Mahon, Esq., M.C.P.
G. D. L. Pile, Esq., B.A., M.C.P.
E. S. Robinson, Esq., M.C.P.
J. D. Chandler, Esq., M.C.P.
H. A. Arthur, Esq., M.C.P.

The Director of Agriculture is an *ex officio* member of the Board.

The Hon. G. L. Pile was granted six months leave from June 1st and Mr. Charles Packer was appointed to act during his absence.

Mr. S. C. Thorne was granted three months leave from July 20th and Mr. E. L. Skeete, B.A., M.C.P., was appointed to act for him.

Mr. G. D. L. Pile resigned his seat on the Board during August and Mr. Henry Alleyne, M.C.P., was appointed in his place.

The Hon : G. L. Pile resigned in April, 1931 and Mr. G. D. L. Pile was appointed in his place.

The Board held nine meetings during the year.

SECTION III.—EXPENDITURE AND REVENUE.

EXPENDITURE.

Personal Emoluments	£8,041	19	6
Overtime Allowance	39	0	0
Travelling Allowances	1,044	4	6
Exhibition	174	10	0
Appointment Expenses of Scientific Officers	68	5	0
Expenses in Control of Sugar Cane Mosaic Disease	1,387	12	2
Expenses in Control of Pink Bollworm of Cotton. (Salaries of Sub-Inspectors of Plant Diseases)	570	8	8
Experiment Stations and Botanic Station	2,264	13	4
Chemical Laboratory	1,176	17	4
Entomology	638	7	2
Sugar Polorization Laboratory	797	11	6
Unforeseen Contingencies	94	11	7
Sundries	375	0	0
Expenses in connexion with duties of Veterinary Officer	27	3	4
Salary of Acting Veterinary Officer for three months	99	3	5
Improvement of Garrison Savannah	50	0	0
Repairs to Polariscope	69	4	3
	£16,918	11	9

REVENUE.

	£		
Sale of Ornamental Plants	30	1	7
Sale of Produce from land leased to Department	105	11	4
Sale of Cane Plants under Mosaic Disease Eradication Act	93	13	1
Fees for Analysis of Sugar and Molasses	1,622	3	0
Fees for Analysis of Miscellaneous Samples	112	9	2
Fees for Fumigation of Schooners, etc.,	44	4	7
	2,008	2	9

In considering the expenditure of the Department of Science and Agriculture which is considerable for the size of the colony it is well that the cost of the various services given to the island should be itemised.

The appropriations for 1931—32 amount to £17,958 and the revenue is anticipated to realise £2,200 which with the free grant of £2,000 from the Empire Marketing Board towards Cane Breeding makes the total cost £13,758.

The expenditure is incurred as follows:—

		£
1.	General Administrative	611
2.	Cane Breeding	5,381
3.	Experimental work other than Sugar Cane	1,169
4.	Control of Pests and Disease	
	(a) Mosaic, Cotton and Gumming	3,007
	(b) Moth Borer	1,648
	(c) Other Services	150
5.	Technological Sugar Research	959
6.	Analysis of Trade Sugars	1,110
7.	Teaching at Harrison College	960
8.	Veterinary Expenses	710
9.	Public Analysts' Department	1,497
10.	Miscellaneous*	756
		£17,958

*Includes £200 (recoverable) for cotton seed cleaning and distribution, £100 Unforeseen Contingencies, £150 Peasants' Show and £50 Free Vegetable Seed for Peasant Farmers.

During the past twelve months every endeavour has been made to decrease expenditure and in spite of increased costs due to increments of salary and new services costing approximately £250 the Estimates have been reduced by over £700. No further reductions are possible if the colony is to retain the present efficient service unless the scope of the Department is curtailed.

It would appear from the above itemised expenditure that savings can only be effected by cutting out some entire specific service, as no further economy is possible from any individual service. If, however, it can be said, and it is considered by the writer to be no exaggeration, that the services designed for the control of plant pests and diseases, teaching and the care of the people's health by the analyses of foods and drugs are proving a sound and necessary investment then how much more profitable is the original work which has kept Barbados in the forefront of the sugar industry.

The sugar canes of Barbados are the sweetest in the world—this high sugar content has not been achieved by chance but by years of unremitting toil—in the past by Bovell and to-day by his successors. What everyone should realise is that Barbados with its comparatively small rainfall, large population and small area must have increased sucrose in the cane and there is no other sugar research station in the world which is working on this problem. To combat the world depression we must either produce sweeter and heavier canes for all parts of the island and all periods of the crop or go out of sugar cultivation altogether.

A fully detailed account of the work of the Department in this connexion appears later in the report but it is pleasing to record that at least one of the canes produced by the Department since the reorganisation holds out especial promise of outyielding the Ba.11569 in the drier parts of the island both in weight and sugar.

SECTION IV.—PLANT INTRODUCTION, DISTRIBUTION AND IDENTIFICATION.

The importation of seeds of various ornamental flowering trees and shrubs was continued during the year.

Importation of seeds and tubers of economic plants is mentioned elsewhere.

The distribution of plants during the year was as follows:—

(a) Ornamental Flowering trees	9
(b) Ornamental foliage trees	427
(c) Other ornamental plants	323
(d) Fruit trees	163
(e) Arbor Day free distribution	6,916
(f) Stizolobium seed	500 lb.
(g) Maize	500 lb.

The Department undertook the organization of the distribution to plantations of sugar cane cuttings of new varieties recommended for trial.

During the course of the year the Department identified a number of plants for enquirers.

SECTION V.—GENERAL COMMENT.

NOTES ON THE SUGAR INDUSTRY.

In a large section of the island the severe drought of 1930 imposed the most unfavourable conditions upon the sugar cane crop experienced since 1920, resulting in the lowest yield per acre of this century in the parishes of St. Philip and Christ Church, and the Lowlands of St. George and St. Michael.

The rainfall during the planting season of 1929 and the first half of 1930 was sufficient to maintain the young crop in an excellent condition to the end of July 1930. Throughout the remainder of the year there was inadequate rain in the greater part of the island, excepting the parishes of St. Joseph and St. John and the highlands of St. George, St. Thomas and St. Andrew. In the latter districts the rainfall was moderate but well distributed and excellent growth was maintained throughout the season.

No relief to the drought was brought to the stricken areas in the early months of 1931, and in those areas the small crop was reaped in less than two months. The quality of the juice was poor in the dry areas, but reached a good standard in the wetter districts.

There was a considerable reduction in the planting of the variety Ba. 11569 owing to its susceptibility to gumming disease which appeared shortly before the planting season in 1929. In the lowlands the varieties B. 374 and B. 726 were substituted for it but these responded poorly to the dry conditions. In the highlands the variety B.H. 10(12) continued to be the predominant variety, but where B. 726 was planted in the wetter districts it outyielded B.H. 10(12).

According to the Customs Returns for the year 1930, 50 tons of White Crystals, 48,355 tons of Dark Crystals, 2,040 tons of Muscovado sugar and 9,085,307 wine gallons of molasses, equal at 110 gallons per puncheon to 82,594 puncheons of molasses of all grades, were exported of the total value of £778,772 made up as follows:—

	Tons.	£.	Value.
White Crystals	50	900	
Dark Crystals	48,355	451,311	
Muscovado	2,040	20,941	£473,152
	50,445		
Molasses.	Gallons.	£.	
Fancy	8,163,338	289,118	
Choice	384,827	12,026	
Vacuum Pan	537,142	4,476	£305,620
	9,085,307		£778,772

TABLE SHOWING EXPORTS OF SUGAR AND MOLASSES FOR THE FIVE YEARS 1925-29 COMPARED WITH EXPORTS OF SUGAR AND MOLASSES FOR THE YEAR 1930.

SUGAR.	1925.	1926.	1927.	1928.	1929.	Average 1925-29.	1930.
Dark Crystal	43,561	42,990	50,221	58,679	62,108	51,512	48,355
Yellow Crystal	10	...	...	...	...	2	...
White Crystal	...	...	...	...	...	...	50
Muscovado	3,889	2,795	2,885	3,980	3,409	3,392	2,040
Actual Sugar Crop, tons	47,460	45,785	53,106	62,659	65,517	54,906	50,445
MOLASSES.							
Fancy	6,880,789	7,085,523	7,294,202	6,199,477	6,377,435	6,767,485	8,163,338
Choice	761,822	431,608	501,640	481,555	579,546	551,234	384,827
Vacuum Pan	208,355	243,203	462,848	548,149	1,078,798	508,271	537,142
Barbados	7,188	...	...	...	...	1,438	...
Special	11,121	...	...	...	...	2,224	...
Total Molasses Crop, gallons ...	7,869,275	7,760,334	8,258,690	7,229,181	8,035,779	7,830,653	9,085,307

The continuation of the depression which hangs over the sugar industry as it does over the majority of industries in the Tropics and elsewhere has been accentuated in Barbados by the visitation of one of the severest droughts on record and it is gratifying to record that under the circumstances no land has gone out of cultivation. It is hoped that now the corner has been turned and with the recent extremely beneficial rains a record crop may be produced which will be sold in a better market.

PEASANT AGRICULTURE.

The year has been an even more disastrous one for the peasant who through lack of organic manures and the thorough cultivation which is characteristic of the majority of planters in Barbados has felt the drought even more severely than his larger neighbour. The low price paid this year by most factories for peasant sugar canes has resulted in serious losses to the peasants, and in addition it should be remembered that although in Barbados there is a necessity for heavy dressings of farmyard manure to increase the humus in the soil, this class of proprietor frequently embarks on sugar planting without access to a reasonable supply of this commodity.

The peasants, however, did well with their cotton and aided by the new system of planting advocated by the Department which together with the free seed provided by the Ginners and the cash purchase of their seed cotton made this crop the sheet anchor of their farming system. This is all to the good as cotton, which unlike sugar, does not respond to heavy dressings of nitrogenous manures is recognised all over the world as pre-eminently a small-holder's proposition.

PEASANTS' CREDIT AND AGRICULTURAL SOCIETIES.

The passing of the Amended Credit Societies Acts opened the way for the formation of Credit Societies on practical lines but in spite of the fact that numerous meetings have been held and also systematic instruction given in the objects and aims of these Societies by the Mosaic and Cotton Inspectors of the Department only one Society has been registered and this Society is largely composed of land holders whose holdings are too small to benefit to any extent by financial assistance.

The present position is that the Barbadian peasant is either so distrustful of his neighbour's commercial morality that he is unwilling to assume the mutual responsibility which all members of Credit Societies must share or alternatively that his financial position is not yet sufficiently serious to actually necessitate his obtaining money to carry on his cultivation.

PEASANTS' AGRICULTURAL SOCIETIES.

During the year under review the peasants in certain parishes, especially St. Thomas, have begun to realise not only the value but the necessity for co-operation in the marketing of sugar cane and ground provisions. The fact that the Barbados Co-operative Produce Marketing Association cannot deal with individual peasant proprietors has also helped in their formation. The Societies are designed to assist their members:—

(a) by the co-operative marketing of all their crops;
(b) by the co-operative purchase in bulk of seeds, manures, etc.;
(c) and especially by their making the peasant cultivator articulate as to his needs and more easy of access for instruction.

Six Societies have already been formed and it is hoped that the smaller cultivators in every parish will realise the benefits that may be obtained from the formation of similar associations.

BARBADOS CO-OPERATIVE PRODUCE MARKETING ASSOCIATION.

Although the Barbados Co-operative Produce Marketing Association is not a part of the Department of Science and Agriculture yet it is considered that its work and its aims are so closely allied with those of the Department that some account of its activities during the past year should be given here.

The object of the Association is by the marketing of its own ground pro-

duce and vegetables to secure a larger proportion of the ultimate proceeds of the sale of this produce to the original producer.

Assistance in the shape of a loan for £500 was given by Government and this has enabled the Association to acquire suitable office accommodation and to make trial shipments of tomatoes and ground produce outside the colony.

It must be realised that the Association cannot properly succeed unless supported by the mass of the producers and also that the Peasants' Parochial Agricultural Societies cannot progress without a successful Co-operative Marketing Association.

THE YIELD OF SUGAR CANE PER ACRE.

The system inaugurated last year by which planters submitted every week during the reaping season returns of the yield per acre of the different varieties grown on their plantations has been continued and extended this year.

Over nineteen hundred returns were received of thirty-four varieties (counting plant canes and ratoons as separate varieties); of these approximately sixteen hundred were received from the following varieties:—

Ba. 11569	Plant Canes.
„	1st Ratoons.
B.H. 10(12)	Plant Canes.
„	1st Ratoons.
„	2nd „
B. 417	Plant Canes.
B. 381	„ „
B. 726	„ „
B. 374	„ „

By comparing the table below with the results of the variety trials appearing later in the report it may be observed how closely they agree (thus demonstrating the lay-out of these trials is calculated to give a very close approximation to the value of the different varieties under the conditions under which they are grown).

TABLE.

SUMMARY OF AVERAGE TONNAGE PER ACRE IN DIFFERENT CLIMATES (1930 RAINFALL ONLY).

	Extra Low Under 30″	Low 30″–38″	Intermediate 39″–48″	High Above 48″
Ba. 11569 Plant Canes	14.7	18.9	22.6	30.0
„ 1st Ratoons	11.0	17.9	26.7	29.5
B. 726 Plant Canes	12.1	15.4	27.2	34.3
B. 417 „ „	10.3	16.9	19.3	..
B.H. 10(12) „ „	10.3	19.0	27.7	32.4
„ 1st Ratoons	11.3	16.2	26.5	29.4
„ 2nd „	..	..	26.4	28.6
B. 374 Plant Canes	12.1	15.1	23.2	30.9
B.381 „ „	11.5	16.6	29.1	34.1

The above table demonstrates that Barbados has a goodly number of canes which are of such equal excellence that it is a matter of extreme difficulty to forecast which will produce the most lucrative crop in the drier areas of the colony. In the hills B. 726 and B.H. 10(12) stand alone.

POLICY IN SUGAR CANE BREEDING.

The absence of any clear cut divisions between varieties in the drier areas of the colony is possibly due to the fact that in the past any seedling which promised to equal the varieties at present grown was submitted to extended trials.

For the future only those seedlings which show definitely better promise will be given prolonged trial and the Department is at present working on a number of seedlings which appear to come within this category.

Many of those interested in the work of the Department are apparently under the impression that new sugar cane varieties can be produced overnight and that even so the expense of their production is prohibitive. That such is not the case is typified by a seedling at present under trial. The parents of this cane (Ba.6032 x Ba.11569) were crossed at Lion Castle in November 1927; it was first reaped as a seedling in March, 1929, and immediately multiplied for planting out in a more extended trial in November of that year. It has since been reaped in March, 1931 and showed such promise that it is being multiplied for the variety trials which will be planted this year and reaped in 1933. In the ordinary way at least three years of variety trials would be necessary to prove its value before making it finally ready for issue (if approved) for planting in the autumn of 1935.

For the future (and in this case), however, whenever a variety shows outstanding promise after its first trial in plots it will be multiplied on such a scale that it can be tried simultaneously on a score of plantations in addition to the variety trials so that one season of variety trials may possibly prove sufficient. This may reduce the period of probation from eight to six years.

It should be borne in mind that varieties can only be grown and recommendations for planting likewise made for normal weather conditions and while it is unfortunate that the new variety B.726 produced such low tonnages in certain parts of the island it should be pointed out that this variety was recommended in districts with an average rainfall of forty to forty-five inches and that under these conditions B.726 was only beaten by B.H.10(12).

EMPIRE MARKETING BOARD.

During the year under review the Department put forward a comprehensive scheme to place sugar cane breeding in the West Indies on a more equitable basis. For every acre of cane planted in Barbados two acres of Barbados canes are grown in the rest of the British West Indies and the scheme aimed at the complete cost of sugar cane breeding being borne (for five years in the first place) by the Empire Marketing Board.

While unable at the moment to decide on its full acceptance the Empire Marketing Board have shown their sympathy with Barbados and their appreciation of the work being carried on by the Department by a free grant of £2,000 towards this year's estimates.

In securing this grant the thanks of Barbados are especially due to Mr. Laurie Pile and Sir Edward Davson.

THE EFFECT OF SCIENCE ON PRODUCTION.

In Plate I the annual sugar crop of the island expressed in thousands of tons of 96° dark crystal sugar, is compared with the average rainfall of the island during the period the sugar cane is grown (16 months), expressed in inches, over a period of eighty-one years. For the purpose of easy comparison the averages of consecutive three-year periods are presented, instead of the actual figures, for individual years.

During the first thirty to forty years of the period the manufacture of molasses (syrup) and sugar was almost entirely carried on in small windmill factories. The gradual increase in the size of the crop during these years was in part due to the higher rainfall after 1873 and in part to the increased planting of the Bourbon cane.

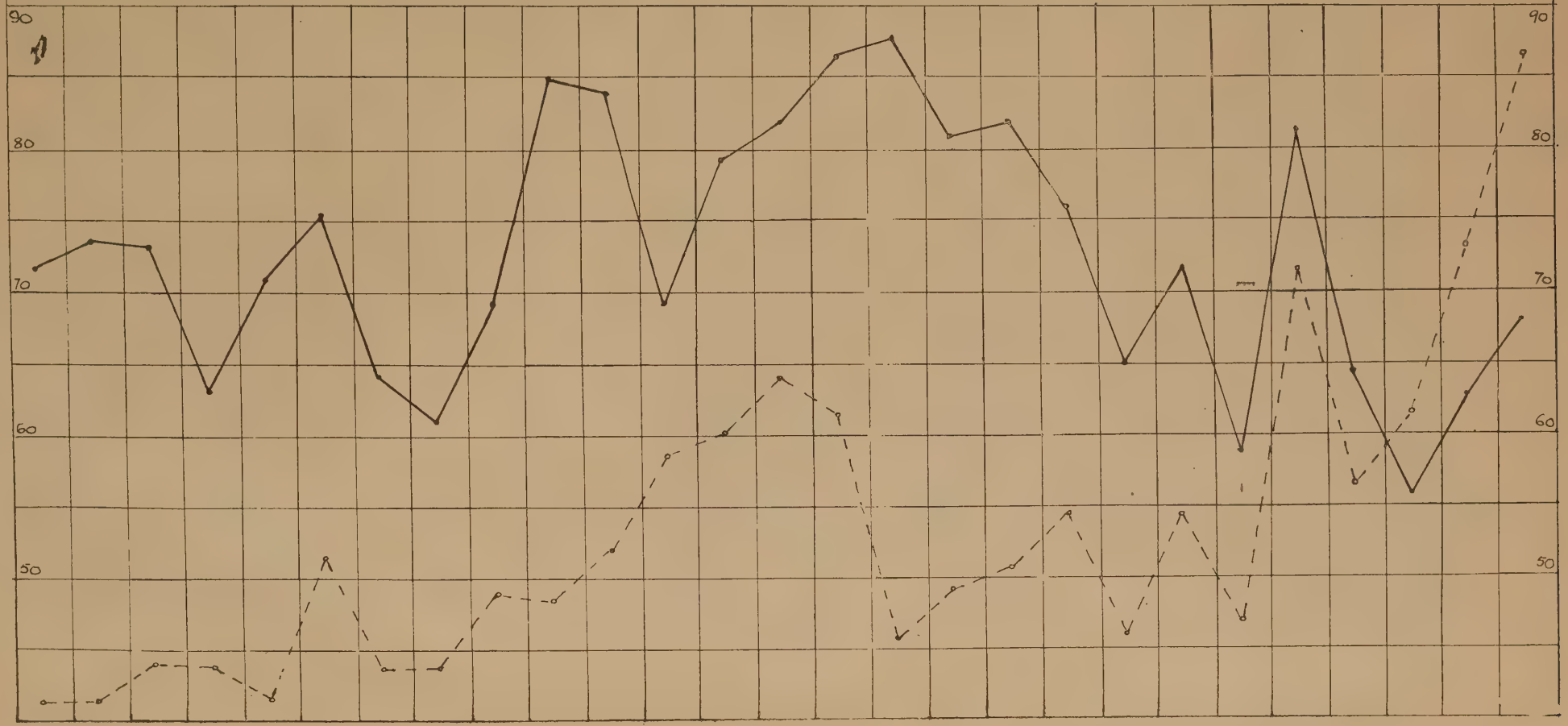
In the early nineties, in spite of continued rainfall, there was a very pronounced decline in the size of the crop. This decline was the result of the collapse of the Bourbon cane under the attack of the rind fungus (*Colletotrichum falcatum*). There was no variety of equal merit to take the place of the Bourbon. For a time White Transparent was extensively planted, and then began in the late nineties the work of J. R. Bovell who raised new seedling varieties with the object of regaining the high standard of the Bourbon cane.

During the first ten years of the present century the improved varieties produced by Bovell, together with a gradual improvement in the manufacturing process, effected by the replacement of a number of windmills by more efficient steam-driven machinery, maintained a fairly even size of crop in spite of a very marked decline in the annual amount of rainfall.

PLATE I.

1850-52	1853-55	1856-58	1859-61	1862-64	1865-67	1868-70	1871-73	1874-76	1877-79	1880-82	1883-85	1886-88	1889-91	1892-94	1895-97	1898-1900	1901-03	1904-06	1907-09	1910-12	1913-15	1916-18	1919-21	1922-24	1925-27	1928-30

The continuous line shows the average rainfall in inches over the sugar cane growing season (16 months) for periods of three years from 1850. The dotted line shows the annual average manufacture of sugar, in thousands of tons, for similar periods of three years over the same time.



In 1912 Bovell's work produced the famous variety B.H.10(12), and in 1915 the variety Ba.11569, but during the previous decade he had gradually improved the economic standard of commercial varieties.

The war period with its rainier years and installation of better machinery, replacing more and more of the old windmills, was responsible for a great increase in the size of the crop. The high standard of the cane varieties and continued improvements in factories resulted in the production of average crops during the very dry years of the twenties.

Since 1921 the crop (in thousands of tons) has exceeded the rainfall in inches and it is interesting to surmise what crop will be produced by the island under the better climatic conditions which pertained, for instance, during the war years.

Plate I shows the great financial return which has been realised in the colony by better machinery and by scientific methods of seedling production.

GARRISON SAVANNAH.

Through the courtesy of the local Agents of Imperial Chemical Industries and the Dominions Potash Syndicate (Messrs. DaCosta and Wilkinson and Haynes) it was found possible to manure the Savannah with a complete dressing of artificial fertilisers kindly given by the principals.

Some forty head of sheep were also purchased and it is hoped that regular cropping will gradually produce a better turf. The Bamboo and Christmas grasses are being eliminated by the local devil's grass, and the value of manurial applications is already apparent.

THE COTTON SITUATION.

The market for the famous Sea Island cotton which grows to perfection in Barbados is in normal times but a small one and with the enormous stocks held in Liverpool there was always the possibility that a large proportion of the lint grown from the 2,800 acres under the crop during 1930—31 would remain unsold. It is gratifying to record that a considerable amount of the crop has already been disposed of at very fair prices and it would appear that provided the seed cotton is picked at the right time, thoroughly dried and properly prepared for market the superiority of the local lint will enable it to continue being grown even though the market may be overstockd with a product which is not so attractive to the spinners.

Nevertheless the fact remains that under present conditions there is no market for all the Sea Island cotton produced in the West Indies. It is also a fact that the spinner will not solve the problem of its disposal and it would appear that the only solution is for Barbados in company with the other cotton growing islands of the Caribbean to consider the possibilities of increasing the present markets and establishing new ones.

SECTION VI.—EXPERIMENTAL WORK OF THE DEPARTMENT.

A. ECONOMIC BOTANY.

The work of the Geneticist is reported more fully in Chapter II.

SUGAR CANE.

The majority of the trials of the Department have suffered very considerably from the great drought experienced in the period under review and this has been especially the case with those of the sugar cane. As has been stated previously the breeding work carried on by the Department is designed to give higher yields during normal seasons and the results recorded after such an abnormal year while generally conclusive in the case of those seedlings and varieties which have done well are not nearly so valuable in the case of those which have failed or shown only a moderate degree of success under conditions under which no sane planter would normally contemplate the planting of sugar cane.

Every year the Department plants out 6,000 sugar cane seedlings for trial under field conditions and it is apparent that numbers of seedlings, which under the average climate of the island might have been selected must have been lost through their inability to thrive in a drought.

Nevertheless the year has not been without its compensations in that a number of seedlings continue to show their early promise and prove that the present scheme of breeding is bound to produce more sugar per acre in the near future.

COTTON.

The Department published a Pamphlet (No. 4) on cotton towards the close of the period reported on last year. This pamphlet advocated a considerably closer planting than had previously been adopted. This closer planting was necessitated by the shorter growing season and to diminish the ravages of pink bollworm. A trial was therefore conducted at Codrington to establish whether the new spacing outyielded the old and as will be seen later in the report the recommendation was fully justified, as the closer spacing outyielded the old by 12% giving a total yield of 1262 lb. of seed cotton per acre.

Although pink bollworm was discovered towards the end of the season yet with the earlier maturity given by the closer spacing no material damage was inflicted.

This trial is being repeated this year.

SWEET POTATO.

Work on the trial of seedlings and varieties of the sweet potato has been proceeded with and it is estimated that the trials now in progress will produce definite results towards better potatoes for storage and scarabee resistance.

SERICULTURE.

The three varieties of Mulberry (Morus) which were tried during the year proved a failure and it has therefore to be recorded that there appears no prospect of establishing a silk industry in Barbados.

B. CHEMICAL SECTION.

An account of the work of this section is given by the Agricultural Chemist and his assistants in Chapter III.

Little research work could be carried out during the crop season of 1931 owing to the compulsory absence on leave of the Agricultural Chemist's Chief Assistant. This necessitated the performance of Police and Public Health analyses, which occupy the undivided attention of one qualified analyst, by the Agricultural Chemist.

Nevertheless progress has been made with the soil survey of the island and a certain amount of experimental work done on the Quick Vinegar Process and on the viscosity of molasses.

The Assistant Analyst while on leave took the opportunity of studying the quick vinegar problem in Canada and from his observations it would appear that the most economical method of producing the vinegar which is essential to the optimum manufacture of fancy molasses would be by the erection of a central plant or by the conversion of an existing windmill plant for this purpose.

C. ENTOMOLOGICAL SECTION.

The report of the Entomologist is presented in Chapter IV.

In spite of the fact that climatic conditions were almost entirely inimical to the parasite of the sugar cane moth borer the Entomologist reports that steady progress is being made towards the reduction of the damage caused by this pest.

The present situation with regard to the control of this pest in the West Indies is ambiguous for while in Barbados it is being attacked by an egg parasite the Empire Marketing Board have made a considerable grant for its destruction by other methods for other islands some of which offer similar conditions to Barbados. During the year under review Dr. Myers, the Entomologist subsidised by the Empire Marketing Board, very kindly introduced a shipment of *Lixophaga* from Cuba but although these hatched out very well no successes in the field have been reported from their introduction.

D. VETERINARY SECTION.

Government veterinary work in Barbados during the last twelve months has been entirely confined to the routine inspection of butchers' meat and Police and Government stock. A valued visit from Mr. E. Montgomery, Adviser in Animal Health to the Colonial Office, afforded a welcome opportunity of visualising the veterinary needs of Barbados which may be briefly summed up in clean milk and better cared for stock.

Fortunately it would appear that the incidence of disease is low.

SECTION VII.—PEASANTS' AGRICULTURAL EXHIBITION.

The usual Exhibition for Peasants and Elementary School children was held, with the kind permission of the Management of Lemon Arbor plantation, on December 3rd, 1930, at Lemon Arbor, St. John.

The Exhibition was very successful and the attendance was almost a record.

In spite of the drought the exhibits reached a very high standard and in many instances compared favourably with those at the bigger show, the Annual Industrial Exhibition.

The limitation of the number of prizes to be won by any individual proved extremely successful and it is hoped that this limitation will be the means of securing many more entries in future years.

The agricultural work attracted a large number of spectators.

While the agricultural practice of the Barbados peasant proprietor is such that it might well be followed with advantage by other similar communities the standard of stock raised and owned by these people is deplorable. It is true that isolated instances occur in which owners exhibit good class animls but as a general rule the less said about the small stock the better.

There is an urgent need for the immediate introduction of better class sheep and goats and there would appear to be a distinct advantage in breeding up better sized donkeys.

The education of small holders in better types of carts and harness is an imperative necessity but until the appointment of a Veterinary Officer who will be entirely available for such work (as apart from the inspection of butchers' meat etc.) there is no possibility of commencing this work.

SECTION VIII.—CROP DISEASES AND PESTS.

The situation with regard to pests and diseases is reported elsewhere.

Gumming disease athough it has spread considerably, has shown no disposition as yet to assume its more serious form and experiments are being continued this year to determine what varieties if any show considerable resistance to the disease.

The long close season and the shorter crop season have proved extremely successful against the pink bollworm of cotton.

The application of modern dust guns against heavy attacks of army worms proved completely successful and these are now being supplied locally together with proved insecticides by private enterprise.

The danger of careless selection of sugar cane setts for planting in spreading mosaic disease has been emphasised by one group of estates in a hitherto almost clean area.

It is no exaggeration to say that without constant inspection the cost to Barbados in sugar lost in this way would have soon run into several thousands of pounds annually and as long as such carelessness remains it will be essential to continue inspections.

Apart from this group of estates it is gratifying to report that the disease is being gradually controlled.

SECTION IX.—METEOROLOGICAL OBSERVATIONS.

A summary and the details of the meteorological observations recorded at the Meteorological Station, Codrington, appear in Appendix I and Appendix II.

SECTION X.—VISITORS.

Among the vistors to the Department during the year under report were His Excellency the Governor Sir William Robertson, K.C.M.G.; The Right Honourable Lord Olivier, P.C., K.C.M.G.; Sir Edward Davson, Mr. G. Evans,, M.A., C.I.E., Principal, Imperial College of Tropical Agriculture, Prof. H. A. Ballou, Commissioner of Agriculture for the West Indies, Dr. S. C. Harland, Geneticist, Cotton Research Station, Trinidad; Dr. J. G. Myers, Entomologist to the Empire Marketing Board, Mr. C. Y. Shephard, Professor of Economics, Imperial College, of Tropical Agriculture, Dr. H. R. Briton-Jones, Mycologist and Bacteriologist, Imperial College of Tropical Agriculture, and a party of Students; Mr. E. Montgomery, Adviser in Animal Health to the Colonial Office, Mr. H. E. Box Etomologist of the Empire Marketing Board and a party of English Public School Boys on an Empire tour.

SECTION XI.—PUBLICATIONS.

Publications issued by the Department during the year, in addition to the Annual Report for the previous year, were:—

Pamphlet No. 5—"Notes on West Indian Hurricanes with Special reference to Barbados by C. C. Skeete, B.A.

„ No. 6—"Agricultural Notes" being Reprints from Articles published from January—June 1930.

„ No. 7—"Control of Field Crop, Garden and Fruit Pests in Barbados" by R. W. E. Tucker, M.A., B.Ed.

The Department has continued the publication of weekly aritcles of agricultural interest in the local Press and these are reprinted and issued to planters at regular intervals.

SECTION XII.—ACKNOWLEDGMENTS.

The Director of Agriculture desires to record his appreciation of the assistance rendered by:—

(1) The Board of Agriculture throughout the year;

(2) The Management of Lion Castle plantation by granting the Department the use of land for conducting sugar cane breeding and by facilitating the work in every way possible;

(3) The Management of Carrington Factory by permitting the Agricultural Chemist to conduct research work in Sugar Technology in Carrington Factory during the grinding season of 1931;

(4) The Management of Lemon Arbor plantation by permitting the use of the factory and yard at Lemon Arbor for holding the Peasants' Agricultural Exhibition;

(5) The Managements of Frere Pilgrim, Lears, Ridgeway and Alleynedale by selling canes to the Department for the purpose of distributing healthy cane cuttings to areas infected with mosaic disease;

(6) The Management of Guinea and Waterford plantations by granting the use of land for sweet potato experiments;

(7) The Managements of Vaucluse and Graeme Hall plantations by granting special facilities for maintaining maturity experiments until the end of the reaping season;

(8) The United States Department of Agriculture by supplying this Department with cuttings of sugar cane varieties passed through quarantine and by supplying seeds of various economic plants;

(9) The local Press and especially the "Advocate" for assisting the Department at all times when publicity has been necessary.

Chapter II

ECONOMIC BOTANY.

REPORT OF THE GENETICIST.

(A. E. S. McINTOSH, B.Sc., Ph.D.)

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SECTION I.—SUGAR CANE.

(*a*) SUGAR-CANE BREEDING.

The ultimate aim of every sugar cane breeder is to increase the production of sugar per acre and to achieve this end not by the haphazard cultivation of a mass of seedlings but by obtaining from each bi-parental grouping (at the same time using as many of these combinations as circumstances allow) a population numerous enough to forecast its value as a possible producer of commercial sugar cane varieties.

The security of intended crossings is provided for by the use of male sterile, or self-sterile varieties as "female" parents, and the guarding of those from promiscuous crossing during the flowering period of their arrows, by means of arrow lanterns and the "dusting" of these arrows in such shelters, by pollen from the selected "male" plants (1).

The following crossings were carried out at Highland plantation—the plantation adjoining Lion Castle—during the arrowing season October-December 1930.

TABLE I.

SCHEDULE OF CROSSES MADE DURING BREEDING SEASON OF 1930.

"Female."	"Male."
Ba.11569	B.H. 10(12), B.606, B.891, B.391, B.755, B.417, B.663, B.605, B.374, B.726.
P.O.J. 2364	B.H. 10(12), B.891, B.374, B.391, B.417.
P.O.J. 2725	B.H. 10(12), B.755, B.391, B.417.
P.O.J. 2354	B.H. 10(12), B.891.
P.O.J. 826	B.H. 10(12), B.374, B.391.
P.O.J. 2379	B.H. 10(12).
Uba	B.H. 10(12), B.726, B.391, B.606.

The foregoing table shows that twenty-nine crosses were employed. The technique employed in the crossing work was essentially similar to that of the two previous years and advantage was taken of the knowledge gained in 1928 and 1929 on pollen shedding (2) for the selection of "male" varieties and in choosing times for cutting the arrows and "dusting" their pollen on to the "female" arrows.

The usual routine observations on varietal flowering phenomena approximated, for varieties already studied, to those recorded in previous years.

Particular attention was devoted to an investigation into the relationships between certain pollen features in several "male" plants and their relative abilities to produce seedlings when crossed with the standard Barbados "female" plant, Ba.11569. The mean germinations per seed box have been ascertained for various crosses with this female parent for one or more years. These are presented below:—

TABLE II.

COMPARISON OF THE AVERAGE PERCENTAGE GERMINATION OF VARIOUS CROSSES OF THE BA.11569 SUGAR CANE VARIETY.

Cross.	Year and Number of Seedlings per box.		
	1928.	1929	1930.
Ba.11569 x B.391 ..	99.5	170.0	191.7
„ x B.H.10(12) ..	92.3	191.6	144.0
„ x B.417 ..	..	177.0	130.7
„ x B.755 ..	..	165.2	104.1
„ x B.606 ..	22.8	36.2	115.2
„ x B.605 ..	..	51.0	51.0
„ x B.891 ..	..	36.0	42.0
„ x B.374 ..	..	40.0	11.8
„ x B.726 ..	..	..	22.2

It can be seen from the above table that the viability of seeds produced by the crosses tends to vary and preliminary investigations were made to ascertain whether any relationships existed between pollen features in these "male" varieties and their abilities to produce seedlings. The practical value of such an investigation is obvious,, if it should only reveal a ready method of forecasting the viability of the seeds of "male" plants employed in breeding for the first time.

Accordingly, pollen studies were made on the nine "male" varieties listed above.

Around the optimum shedding period on each of eighteen mornings, samples of fresh pollen from each variety were collected by dusting from arrows on to grass plates.

Two hundred pollen grains were examined from each plate over a series of microscopic fields and the percentage of abnormal grains noted.

The grains were then stained with iodine and the percentage occurrence of normal shaped grains staining blue with iodine obtained in a similar manner. Further, on each of nine mornings the diameters of forty normal grains chosen at random in several microscopic fields were determined.

The following data overleaf present a summary of the results:—

TABLE III. THE COMPARISON OF THE POLLEN GRAINS OF VARIOUS MALE PARENTS.

	Pollen.													
	Abnormal Shape.				Normal Shape.									
	Percentage Occurrence.				Iodine Staining.					Grain Diameter.				
Variety.	Total Number of grains over all counts.	No samples.	Mean % abnormality.	Variance of mean.	Variety.	Total No. grains in count.	No. samples.	Mean % Iodine staining.	Variance of mean.	Variety.	No. grains.	Mean diameter.	Variance of mean.	Percentage standard deviation.
B. 391 ...	3,800	19	1·32	0·037	B. 391 ...	3,800	19	85·2	1·481	B. 606 ...	450	41·534	0·039	11·60
B. 417 ...	3,200	16	4·75	0·299	B. 417 ...	3,200	16	82·2	2·267	B. 891 ..	450	38·131	0·066	14·32
B.H. 10(12)	3,800	19	5·53	0·193	B. 605 ...	3,000	15	82·2	1·882	B. 374 ...	450	37·527	0·044	11·97
B. 726 ...	3,400	17	7·98	1·111	B. 726 ...	3,400	17	80 5	2·035	B. 726 ..	450	37·333	0·028	9·55
B. 605 ...	3,000	15	8·80	1·271	B. 374 ...	3,800	19	80·3	0·926	B. 391 ..	450	37·291	0·023	10·29
B. 755 ..	3,200	16	10·75	2·071	B. 606 ...	3,400	17	79·7	1·649	B 417 ...	450	37·173	0·038	11·08
B. 374 ...	3,800	19	11·05	2·053	B.H. 10(12)	3,800	19	77·6	0·961	B.H. 10(12)	450	36·444	0·036	11·01
B. 606 ...	3,400	17	13·00	3·800	B. 891 ...	3,600	18	72·1	3·470	B. 605 ...	450	36·435	0·040	11·65
B. 891 ...	3,600	18	13·44	2·098	B. 755 ...	3,200	16	55·1	9·477	B. 755 ...	450	34·529	0·044	11·08

Statistical Note: Where the difference between any two means is greater than twice the square root of the sum of the variance of their means, then that difference may be regarded as a significant one.

To the above data can be added, for each variety, a note on its intensity of pollen shedding. These are deduced from quantitive data collected in 1929 and 1930 and from observations made during the dusting period. The following is an arbitrary classification:—

High pollen shedding varieties	B.391, B.H.10(12), B.374.
Intermediate pollen shedding varieties.....	B.606, B.605, B.417.
Lower pollen shedding varieties	B.891, B.755, B.726.

It should however, be recorded, that all the above varieties appeared to furnish pollen in an amount sufficient to serve receptive stigma, and moreover, since there was no necessity to economise in "male" arrows, the tendency was to dust in excess of apparent requirements. In the descendants of these varieties, therefore, seed viability does not appear to be a question of pollen shortage. This leads to a consideration of the data obtained by microscopic examination.

There does not appear to be any relationships between the mean pollen grain diameters and fertility. On the other hand, there is an indication that those "male" plants with the more uniform-sized grains—as shown by the percentage standard deviations column—tend as crosses with Ba.11569 to give a higher number of seedlings. The variety B.726 is the only exception to this rule in the varieties investigated. The percentage of normal-shaped grains staining blue with iodine does not seem to be any indication of the seedling producing power, of any variety used in this particular experiment. Seedling producing power, however, does seem to be associated with pollen grain shape abnormality. Again, with the exception of B.726, a low occurrence of abnormally shaped grains seems, in any variety, to accompany high seedling producing powers.

Factors Affecting Germination of the Fuzz.

In continuation of last year's investigation into the factors influencing the germination of fuzz additional evidence has been accumulated with the following indications:—

(a) The effect of the particular cross on fuzz germination.

It was found that Java-Barbados crosses are less fertile than Barbados-Barbados crosses: and that for any female different male parents show differences in the viability of the resulting seeds.

(b) The effect of the female plant (stool) and/or arrow lantern employed on fuzz germination.

The results of this year's investigation support those of the previous year, in that "comparable" fuzz from arrows of stools under different lanterns give wide divergences in germination, indicating that other factors exert a much greater influence.

(c) The effect of time allowed for seed maturation after picking on fuzz germination.

Periods of three, eight and fourteen days were allowed for seed maturation. The results indicate that the shorter period of three days is more favourable to higher germination than periods of eight or fourteen days.

(d) The effect of the arrow on fuzz germination.

In any one stool three, four or more arrows were allowed to grow up into the superimposed lantern. These arrows naturally had different dates of emergence and the investigation arrived at discovering whether such differences in the date of emergence had any relation to the number of seedlings obtained. A negative result was however obtained for this experiment.

Seedling Selection Prior to Planting in the Field.

Table 4 gives the details of those seedlings chosen for further observation in pots before planting out for trial under field conditions. At this stage only green healthy seedlings are considered—chlorotic and red seedlings and those lacking in growth vigour being eliminated.

The various populations are divided into two groups for early and late reaping in 1932.

From the findings of experiments of 1929 and 1930, selection within any group of the more vigorous seedlings in the potted stage for planting out was found to be justifiable on the grounds that by this procedure seedlings with a higher average weight were obtained. This method of selection was therefore continued this year.

TABLE IV.

DETAILS OF SEEDLINGS PLANTED IN THE FIELD.

Cross.	Number potted.	No. planted into field from pots. Group.			
		Early.	Late.	Total.	
Ba.11569 x B.H.10(12)	2978	600	600	1200	
„ x B.891	1319	410	350	760	
„ x B.391	988	400	340	740	
„ x B.417	1166	200	200	400	
„ x B.606	1200	200	200	400	
„ x B.374	450	150	150	300	
„ x B.726	370	200	150	350	
„ x B.755	890	120	120	240	
„ x B.605	500	100	100	200	
„ x B.663	56	..	50	50	4640
P.O.J.2364 x B.391	244	100	100	200	
„ x B.374	160	70	70	140	
„ x B.891	112	50	50	100	
„ x B.H.10(12)	103	..	80	80	
„ x B.755	45	..	40	40	560
P.O.J.2725 x B.H.10(12)	692	150	150	300	
„ x B.391	460	150	150	300	
„ x B.755	274	100	100	200	800
Totals	11,007	3,000	3,000		6,000

In the above table it may be observed that the Barbados-Barbados crosses occupy over 75% of the total plantings and the remaining 25% is planted with Java-Barbados crosses.

In each group of three thousand seedlings, the individual seedlings of each and every population were placed at random in three thousand cane hole areas of soil on the experimental station, as this is considered to be the best method for contrasting populations from crosses.

(b) FIRST YEAR SEEDLINGS.

The results from experiments, recorded on pages 26-30 of last year's report, of correlating the vigour of seedling "batches" with their weights at crop time have not given a sufficiently high correlation to warrant this trial being repeated at present.

First Year Seedlings—Reaped at Codrington 1931.

These seedlings are those bred in 1929 and planted out in April 1930. They represent one stage in advance in the system over the seedlings mentioned above and details of the planting out are given in the 1929-30 Report on pages 26-31. There it was seen that three groups—early, medium and late—of ap-

proximately two thousand seedlings each, were planted from plots into the field. In all, populations from twenty-five crosses were included, and in any one group every seedling was placed at random in the soil area of that group. Thus this latter procedure not only provided a medium for the selection of what were considered the most promising first year seedlings, but also gave valuable information on the relative values of cross populations, which information throws light on the hereditary tendencies of the parent plants and admits of a more effective grouping of parents in breeding. At the same time the relative values of crosses are determined and this admits of an expansion in population numbers of the more valuable crosses and an elimination of the inferior ones. It must, however, be stated here, that one year alone is not considered sufficient to pronounce judgments on the crosses with a view to their further treatment, since there appears to be a considerable differential response by cane varieties to different environments, and it might be premature to condemn or appraise the relative values of crosses on performances under one set of conditions only. For example, the rainfall—which in Barbados appears to be the all important growth-affecting factor—for the year 1930 was extremely low and stool weights of seedlings were correspondingly much below the weights of an average rainfall year. It is not, therefore, considered that the relative placing of the crosses under these conditions is of necessity what would have obtained under conditions of average or above average rainfall. Hence the necessity arises to study the value of different crosses over a period of years in the chances of getting varied rainfalls over these years. It is seen from Table 8 that, while there has been a tendency to expand the proportionate representation of those crosses which have done well previously, yet, crosses which have not performed well are still included in numbers sufficient to establish reliable averages for the particular features considered.

The early group was reaped from the 12th—15th January, the medium from 2nd—5th March and the late from 13th—16th April.

The procedure for each group was the same. For purposes of field selections each seedling had the following features noted (1) habit (2) thoroughness of trashing (3) number of canes (4) length and width of an average sized cane (5) weight of stool. Since all except (2) are certainly influenced by place in the field, each two thousand group was subdivided into smaller blocks and selection made within blocks. In all approximately one hundred and twenty seedlings were selected in each group in the field. Each bundle was divided into two, so that there were comparable pairs of canes in each half. One half was sent to the mill for sucrose percentage in juice determinations, while the other half was retained at the experimental station. The latter provided a sample for observing the types of the canes in the seedlings. Thus, with all features ascertained, a final selection of twenty seedlings was made in each group.

Field characters were obtained for all members of each population, while sucrose percentages were determined for a sample number of each population; such numbers being selected from all parts of the experimental area.

The following tables give indications of the relative performances of cross populations in each group reaped.

TABLE V.

1ST YEAR SEEDLINGS REAPED AT CODRINGTON 1931 SHOWING THE RELATIVE CONTRIBUTIONS OF CROSS POPULATIONS TO FIELD AND FINAL SELECTIONS.

(i) GROUP: EARLY.

Cross.			Number Reaped.	Number selected in Field.	Percentage field selection.	Percentage final selection.
Ba.11569	x	B.H.10(12) ..	352	29	8.24	3.14
„	x	B.374	199	9	4.50	1.50
„	x	B.391	146	11	7.54	0.66
„	x	B.755	144	3	2.08	0.66
„	x	B.891	197	15	7.61	2.50
„	x	B.417	152	18	11.84	3.33
P.O.J.2364	x	B.391	179	21	11.73	1.11
„	x	B.417	40	6	15.00	0.00
P.O.J.2725	x	B.391	203	12	5.91	0.50
„	x	B.891	57	3	5.26	0.00

(ii) GROUP : MEDIUM.

Cross.	Number Reaped.	Number Selected in Field	Per cent. Field Selection.	Per cent. Final Selection.
Ba. 11569 x B.H. 10 (12) ..	340	18	5·3	2·94
,, x Ba. 6032	98	11	11·2	2·00
,, x B. 606	350	16	4·6	0·86
,, x B. 374	131	3	2·3	0·00
,, x B. 755	63	0	0·0	0·00
,, x B. 417	99	5	5·0	2·00
,, x B. 605	103	2	2·0	0·00
P.O.J. 2364 x B. 374	193	28	14·5	0·00
P.O.J. 2725 x B.H. 10 (12) ...	148	6	4·0	0·00
,, x B. 374	98	1	1·0	1·00
,, 2379 x B. 374	50	8	16·0	0·00

(iii) GROUP : LATE.

Cross.	Number Reaped.	Number Selected in Field	Per cent. Field Selection.	Per cent Final Selection.
Ba. 11569 x B.H. 10 (12) ...	250	18	7·2	1 2
,, x Ba. 6032	250	14	5·6	2·0
,, x B. 606	250	13	5·2	0·4
,, x B. 605	250	3	1·2	0 0
P.O.J. 2364 x B.H, 10 (12)	160	31	19·4	0·6
,, x B. 606	59	14	23·7	0·0
,, x B. 605	18	4	22·2	0·0
P.O.J 2725 x B.H. 10 (12) ...	155	8	5·2	3·2
,, x B. 606	40	0	0·0	0·0
Co. 213 x B. 374	64	2	3·1	0·0

TABLE VI.

1ST YEAR SEEDLINGS REAPED AT CODRINGTON 1931 SHOWING FOR SEVERAL FEATURES THE RELATIVE MERITS OF CROSS POPULATIONS.

(i) GROUP : EARLY.

(a) *Weight.*

Cross.	Number of Stools.	Mean Weight per Stool.	Standard Deviation.	Per cent. Standard Deviation.	Variance* of Mean.
P.O.J. 2364 x B. 417 ...	37	25·84	± 10·62	41·09	3·046
,, x B. 391 ...	164	25·73	± 11·07	43·02	0·747
Ba. 11569 x B. 417 ..	149	20·00	± 9·94	49·70	0·652
,, x B. 391 ..	135	19·36	± 9·48	48·96	0·665
,, x B.H. 10 (12)	325	19·02	± 9·68	50·89	0·280
,, x B. 891 ...	188	17·72	± 9·15	51·63	0·445
P.O.J. 2725 x B. 391 ...	176	17·54	± 11·25	64·13	0·718
Ba. 11569 x B. 755 ..	133	16·43	± 8·18	49·79	0·504
P.O.J. 2725 x B. 891 ..	50	15·25	± 10·32	67·67	2·128
Ba. 11569 x B. 374 ...	182	14·95	± 8·21	54·92	0·371

*Statistical note: Where the difference between any two means is greater than twice the square root of the sum of the variances of their means, then that difference may be regarded as a significant one.

(ii) (b) *Percentage Sucrose in Juice.*

Cross.	Number of Stools.	Mean per cent. Sucrose Stool.	Standard Deviation.	Per cent. Standard Deviation.	Variance of Mean.
Ba. 11569 x B.H.10(12)	96	14·93	± 1·546	10·36	0·0248
,, x B. 891 ...	77	14·50	± 1·683	11·61	0·0368
,, x B. 417 ...	79	13·83	± 1·801	13·02	0·0416
,, x B. 391 ...	72	13·49	± 1·694	12·56	0·0404
,, x B. 755 ...	49	13·46	± 2·092	15·54	0·0912
,, x B. 374 ...	62	13·37	± 1·550	11·59	0·0393
P.O.J.2725 x B. 391 ...	70	12·96	± 2·165	16·86	0·0679
,, x B. 891 ...	20	12·94	± 2·373	18·34	0·2964
P.O.J.2364 x B. 391	83	11·31	± 2·038	18·02	0·0506
,, x B. 417 ...	27	11·27	± 1·777	15·77	0·1215

(iii) (c) *Canes.*

Cross.	Number of Stools. reaped	Mean Number of Canes per Stool.	Mean Length of Canes per Stool.	Mean Width of Canes per Stool.
P.O.J. 2364 x B. 391	166	14·63	45·05	1·292
,, x B. 417	37	13·79	48·00	1·256
Ba. 11569 x B. 391	136	10·88	43·30	1·251
P.O.J. 2725 x B. 891	50	10·76	43·18	1·197
,, x B. 391	168	10·67	41·08	1·244
Ba. 11569 x B. 891	187	10·49	43·53	1·238
,, x B.H. 10(12) ...	332	10·33	45·47	1·261
,, x B. 374	184	10·10	42·87	1·233
,, x B. 755	132	10·04	41·60	1·227
,, x B. 417	144	9·89	47·51	1·258

(iv) (d) *Number of Rotten Canes.*

Cross.	Number of Stools.	Rotten Canes per Stool.	Percentage Occurrence per Stool.
P.O.J. 2725 x B. 891	50	1·420	13·19
,, x B. 391	168	0·821	7·69
P.O.J. 2364 x B. 391	166	0·970	6·63
Ba. 11569 x B. 755	132	0·651	6·51
,, x B. 374	184	0·554	5·48
P.O.J. 2364 x B. 417	37	0·730	5·29
Ba. 11569 x B. 891	187	0·492	4·69
,, x B. 417	144	0·458	4·63
,, x B. 391	136	0·462	4·25
,, x B.H. 10 (12) ...	332	0·373	3·61

GROUP: MEDIUM.

(i) (a) *Weight.*

Cross.	Number of Stools.	Mean Weight per Stool.	Standard Deviation.	% Standard Deviation.	Variance of Mean.
P.O.J. 2364 x B. 374 ...	170	27·46	± 12·352	44·98	0·897
,, 2379 x B. 374 ..	44	23·00	± 13·171	57·27	3·941
Ba. 11569 x B.H. 10(12)	294	21·40	± 10·960	51·21	0·409
,, x Ba. 6032 ...	74	21·12	± 11·028	52·21	1·642
,, x B. 417 ...	80	20·38	± 9·831	48·23	1·208
,, x B. 606 ...	358	18·86	± 9·509	50·42	0·253
,, x B. 605 ...	70	16·54	± 9 055	54·74	1·171
,, x B. 755 ..	70	16·05	± 8·367	52·13	1·250
P.O.J. 2725 x B.H. 10(12)	110	15·65	± 8·419	53·79	0·650
Ba. 11569 x B. 374 . .	102	15·20	± 9·577	63·00	0·917
P.O.J. 2725 x B. 374 ..	64	14·86	± 9·086	61·14	1·289

(ii) (b) *Sucrose Percentage in Juice.*

Cross.	Number of Stools.	Mean % Sucrose per Stool.	Standard Deviation.	% Standard Deviation.	Variance of Mean.
Ba. 11569 x B.H. 10(12)	92	17·88	± 1·119	7·93	0·0219
P.O.J. 2725 x B.H. 10(12)	67	16·87	± 1·607	9·53	0 0385
Ba. 11569 x B. 417 ...	71	16·73	± 1·369	8 18	0·0268
,, x B. 605 ..	57	16·36	± 1·823	11·14	0·0583
,, x B. 755 ...	24	16·28	± 1·602	9·84	0 0755
,, x Ba. 6032 ...	63	16·18	± 1·601	9·89	0·0407
,, x B. 606 ..	89	16·14	± 1·336	8·28	0·0201
,, x B. 374 ...	74	15·68	± 1·345	8·58	0·0245
P.O.J. 2379 x B. 374 ...	37	15·62	± 1·308	8·37	0·0462
P.O.J. 2725 x B. 374 ...	38	15 54	± 1·948	12 53	0·0999
P.O.J. 2364 x B. 374 ...	86	14·17	± 1·532	11·02	0·0284

(iii) (c) *Canes.*

Cross.	Number of Stools.	Mean Number of Canes per Stool.	Mean Length of canes per Stool. Inches.	Mean Width of canes per Stool. Inches.
P.O.J. 2379 x B. 374	49	12·98	51·43	1·173
P.O.J. 2364 x B. 374	193	12·37	53·26	1·255
Ba. 11569 x B.H. 10(12) ...	332	9·79	51·38	1·239
,, x Ba. 6032	94	9·53	53·11	1·239
P.O.J. 2725 x B. 374	86	8 67	44 55	1·207
Ba. 11569 x B. 374	124	8·66	47·20	1·204
,, x B. 605	93	8·64	50·21	1·237
,, x B. 755	61	8 56	47·25	1·182
P.O.J. 2725 x B.H. 10(12) ...	129	8·54	48·43	1·257
Ba. 11569 x B. 606	342	8·50	49·95	1·284
,, x B. 417	97	8·34	54·00	1·273

(iv) (d) *Number of Rotten Canes.*

Cross.	Number of Stools.	Number of Rotten Canes per Stool.	Percentage Occurrence per Stool.
P.O.J. 2725 x B.H. 10(12)	125	2·320	27·17
,, x B. 374	82	1·991	22·96
Ba. 11569 x B. 605	338	1·719	20·22
,, x B. 605	92	1·717	19·98
P.O J. 2379 x B. 374	48	2·458	18·99
P.O.J. 2364 x B. 374	192	2·208	17·85
Ba. 11569 x B. 374	120	1·508	17·41
,, x B 417	97	1·330	15·95
,, x B. 755	68	1·312	15·33
,, x B.H. 10(12)	333	1·498	15·30
,, x Ba. 6032	94	1·436	15·07

GROUP: LATE.

The members of this group were reaped in mid-April. They, therefore, had passed through a period of prolonged drought prior to cutting. As a consequence many canes were completely dry; in some stools every cane was dry. This feature differs between the groups and gives valuable information on the existence of parent varieties whose seedlings inherit a greater tendency than those of the others to withstand the rigours of this lengthy dry period. In the following tables for this late group, for each combination, the number of dead stools is expressed as a percentage of stools reaped. Again the number of rotten canes is considered only for living stools and is expressed for each as the mean number of dead canes as a percentage of the living canes. The importance of these results is stressed in the discussion which follows.

The tables are presented below:

TABLE VIII.

(a) *Weight (Living Stools Only).*

Cross.	Number Reaped.	Mean Weight per Stool. Lb.	Standard Deviation.	Variance of Mean.
P.O.J.2364 x B.605	18	31.31	± 19.031	25.900
Co. 213 x B.374	64	28.26	± 13.492	2.891
P.O.J. 2364 x B.606	59	28.15	± 14.661	3.583
P.O.J.2364 x B.H.10(12)	160	26.62	± 13.715	1.176
Ba.11569 x B.H.10(12)	249	20.17	± 9.174	0.337
,, x Ba.6032	250	20.12	± 8.730	0.305
,, x B.606	249	19.58	± 9.299	0.346
P.O.J.2725 x B.H.10(12)	155	19.44	± 8.709	0.489
,, x B.606	40	17.25	± 8.189	3.352
Ba.11569 x B.605	250	15.61	± 6.273	0.157

(b) *Sucrose Percentage in the Juice.*

Cross.	Number of Stools Anaylsed.	Mean Sucrose Percentage per Stool.	Standard Deviation.	Variance of Mean
Ba.11569 x B.H.10(12)	91	17.32	± 1.642	0.0333
P.O.J.2725 x B.H.10(12)	65	16.48	± 1.681	0.0441
Ba.11569 x Ba.6032	83	16.03	± 1.722	0.0361
,, x B.606	87	15.95	± 1.796	0.0375
,, x B.605	49	15.72	± 1.840	0.0704
Co.213 x B.374	42	15.43	± 2.093	0.1043
P.O.J.2364 x B.H.10(12)	97	15.05	± 1.648	0.0280
,, x B.606	44	14.59	± 2.310	0.1240

(c) *Canes (Living Stools).*

Cross.	Number of Living Stools.	Mean Number of Living Canes per Living Stool.	Mean Number of Dead Canes per Living Stool.	Total Mean Number Canes per Stool.
Co.213 x B.374	53	18.53	3.81	22.34
P.O.J.2364 x B.605	16	11.12	5.00	16.12
„ x B.H.10(12)	142	10.90	5.22	16.12
„ x B.606	54	10.79	3.37	14.16
P.O.J.2725 x B.H.10(12)	87	8.13	3.95	12.08
Ba.11569 x B.H.10(12)	170	7.77	3.51	11.28
P.O.J.2725 x B.606	20	7.55	3.85	11.40
Ba.11569 x B.606	164	7.38	4.17	11.55
„ x Ba.6032	145	7.21	4.52	11.73
„ x B.605	80	6.70	5.43	12.13

(d) *Number of Rotten Canes.*

Occurrence of Dead Shoots.

	DEAD STOOLS.			LIVING STOOLS.		
	No. Reaped.	No. Dead.	Percentage Dead.	No. Living.	Mean No. Rotten Canes per Stool.	Percentage Rotte Canes as percentage Sound Canes.
P.O.J. 2361 x B. 606 ...	59	5	8·5	54	3·37	31·23
„ x B. 605 ...	18	2	11·1	16	5·00	44·16
„ x B.H. 10(12)	160	18	11·2	142	5·22	47·88
Co. 213 x B. 374 ...	64	11	17·2	53	3·81	20·56
Ba. 11569 x B.H. 10(12)	249	79	31·8	170	3·51	45·17
„ x B. 606 ...	249	85	34·1	164	4·17	56·44
„ x Ba. 6032 ...	250	105	42·0	145	4·52	62·69
P.O.J. 2725 x B.H. 10(12)	155	68	43·9	87	3·95	48·58
„ x B. 606 ...	40	20	50·0	20	3·85	50·99
Ba. 11569 x B. 605 ...	250	170	68·0	80	5·43	81·04

Discussion on the Data from Reaping of First Year Seedling Populations and indication of Future Line of Work in Sugar Cane Breeding Derived from the Data.

In the introduction to this section on the results from reaping the first year seedlings, emphasis was laid on the fact that these results are primarily of value for the conditions obtaining during the growing season of these seedlings and attention is drawn again to the existence of differential responses by cane varieties in Barbados to different seasons. It is thought, however, that the data for Barbados give a clear impression of the relative values of seedling populations under a very unfavourable growing season (when rainfall was extremely low) and for a very dry crop season. It is considered that the data in the late group—presenting the extent of drying out in populations—furnish valuable information on the abilities of certain parents to produce seedlings which are better fitted to withstand a prolonged drought.

So far as can be ascertained there had previously been no mingling of "blood" other than that of the noble canes (*Saccharum officinarum*) in seedling

production in Barbados. The commercial canes were in the main the outcome of seedlings derived from fuzzes of open arrows of "noble" canes or from selfings. This procedure might, if continued indefinitely, make the production of promising seedlings, (i.e. seedlings which might reasonably be expected to outyield the standard varieties grown in the island to any considerable extent) difficult and laborious. This restriction of variability is well seen in the expressions of the features of value noted in the Tables for the crosses between Barbados canes. These tend to be grouped together. It is, however, true that there are differences and that some combinations are consistently good in such crosses, e.g. Ba.11569 and B.H.10(12).

In 1928 crosses were made between Barbados canes and the Java canes of the "Glajah" nobilisation group. These have been persisted with by the use of Java parents such as P.O.J. 2364, 2725, 2379. Last year, but more particularly this year, the results of such crossings are evident. By a study of the tables, but more particularly from distribution graphs it has been observed that there has been introduced a greater range of the important features (weight and its contributors and sucrose in the juice) than was apparently possible in seedlings from Barbados crosses only.

This fact therefore makes it possible to have seedlings in the first year presenting a more favourable medium for selection of promising individuals. But even of greater importance is the increased weight over the Barbados crosses as shown by the Barbados-Java crosses (more especially when P.O.J.2364 and 2379 are used as female plants). The mean weights of seedlings from the latter crosses are seen to be in excess of those of the former by 20% to over 30%. It is gratifying to note that the greater increase is in the "late" group, and argues for the ability of these seedlings to withstand dry conditions during crop—a highly desirable feature for the greater portion of the arable acreage of Barbados. The success of these crosses, so far as their weights are concerned, is best seen in their percentage field selection, where weight of stool and growth habit are stressed for selection purposes. Unfortunately, however, their sucroses are low and this accounts for the elimination or at most the very small percentage final selections noted. It is clear, however, that their crossings with Barbados canes has raised the sucrose percentages on the average well above those of their "female" parents. P.O.J.2364 itself, as seen from "maturity" experiments, gives on an average about 13%—14% sucrose in its juice, while P.O.J. 2379 does not seem to exceed an average of 15%. In their seedlings, however, derived from their crossing with good sucrose Barbados "male" parents the averages are higher and in a few cases seedlings are obtained with sucroses of over 18%. From this it appears that the infusion of the Barbados "parents" blood is assuredly raising the juice qualities.

The seedlings of P.O.J. 2364 crosses have an excellent appearance—not so those of P.O.J.2379. These latter tend to have narrow canes and do not ap- the promise of the P.O.J. 2364 crosses. The P.O.J.2725 crosses do not appear to provide seedlings whose weight distributions extend beyond those of seedlings from the Barbados crosses. There is a suggestion that these seedlings, however, do not tend to deteriorate in juice qualities towards the end of crop as do the crosses in Barbados canes. This point, however, does not appear to be definite and will have to await further investigation.

Seedlings from Co.213 crosses, while giving good weights, and withstanding the dry crop season well, are only mediocre in juice qualities. Their appearance, however, is against them; their canes being reed-like as in the "female" parent. They do not suggest a promising line of work in seedling production and will not be recommended for further trial at present.

Within the Barbados crosses there are smaller differences but there are undoubtedly indications of different values. The cross Ba.11569 x B.H. 10 (12) produces seedlings with good weights and very fine juices. These Barbados crosses at the same time reveal the hereditary potentialities of the "male" parents employed. B.H.10(12), B.417, B.391 and Ba.6032 contribute good weight. B.H.10(12) B.891, B.417, contribute good juice qualities. B.606 is intermediate in weight production, while B.605, B.755 and B.374 are definitely inferior. Most of these crosses will, however, be tried again when their relative performances will be again noted, it is hoped, under conditions of more normal rainfall. Thus an endeavour will be made to determine the relative values

of parents for seedling production for different rainfall areas. The obvious line of work in those Barbados crosses is to expand the representation of the good crosses and restrict that of the inferior ones and this has been done this year.

Finally the most promising-line of work in breeding good seedlings, which appears to present itself, is to back cross the best of the P.O.J. 2364 x Barbados "male" parent crosses with high sucrose-endowing Barbados "male" parents, viz., B.H.10(12), B. 891 and B.417. This is in the hope of retaining the weights, appearances and drought resisting properties of the first crosses and grading these up in juice quality as near as possible to the best Barbados canes in this respect.

With this end in view those P.O.J.2364 crosses which gave high weights and a reasonably good sucrose percentage were selected and planted out at Lion Castle for flower studies and subsequent use as parent plants for use as "males" or "females" in crossing with the Barbados "male" plants B.H.10(12), B.891 and B.417.

(*c*) CORRELATION EXPERIMENTS.

These experiments, which are being conducted over a period of years, are designed to determine how far the relative performances of individual members of seedling populations in any growing season are sustained in subsequent growing seasons and under varying climatic conditions. The features of chief importance in seedling selection work are the weights and sucrose percentages in the juices of the seedlings in the populations. Seedling selection in the first year is largely influenced by the extent of these characters. It is well known, however, that these features are variable in adjacent stools in any one variety in any one field, and since a seedling in its first year has only one stool from which its merit must be established, the question arises to what extent reliability may be placed on a judgment based on these features.

It is, therefore, necessary to estimate for a population of first year seedlings, chosen from a small soil area, the extent of agreement of the relationship of any feature, which exists between its members, in the first year and in successive years of growing. For example, the members of a population of first year seedlings hold, for weight, definite relationships one to another. It would be necessary, if selection in the first year based on weight were to be of any value, that an approximately similar relationship between the members held in following years.

The coefficient of correlation for weight in members of a population, between their weights in first and following croppings, estimates the extent of agreement in their relative weights at first and following crop seasons.

In the Report of this Department for 1928-29, page 38, the results were given for a weight correlation experiment in nineteen seedlings between their first and second year's weights. The figure obtained was +0.8371 (P=.01). This population was grown again as a third year seedling group (1929-31). Each seedling was replicated four times in randomised blocks and the plot contained twelve cane holes.

With a precisely similar layout a large weight correlation experiment was carried out in conjunction with this trial in which forty seedlings, reaped as first year seedlings in 1929 and selected so that their individual weights comprised a wide range (15 lb.—88 lb.)

The results of these weight correlation experiments are given below.

TABLE IX.

CODRINGTON—WEIGHT CORRELATION COEFFICIENTS FOR POPULATIONS OF SEEDLINGS GROWN OVER SEVERAL CROP YEARS.

Seedling Population.	Number of Seedlings.	Seedling Years.	Correlation Coefficient	Probability (P).
B(28) 1—19 ..	19	1st & 2nd	+ 0.837	> .01
B(28) 1—19 ..	19	1st & 3rd	+ 0.591	> .01
B(28) 1—19 ..	19	2nd & 3rd	+ 0.698	> .01
C 1 — C 40 ..	40	1st & 2nd	+ 0.498	> .01

All the correlation coefficients are significant and moreover, reveal the existence of a high positive tendency for the members of first year seedlings to retain their relative positions in weight over a number of croppings.

It is hoped to increase the coefficient of correlation between first and subsequent year seedling groups, by restricting the area from which is drawn that first year population to be correlated with its second year vegetative generation. This is on the assumption that, (excluding sporadic interferences such as moth and root borer) the relative weights of the seedlings within a small area of soil are truer indices of their relative yielding capacity, than when comparisons are made over a wider soil area. Selection of forty seedlings for weight and sucrose percentage in juice correlations between first and second year crops, has, this year been made over as small an area as possible. At the same time, wherever the weights of stools have been affected by unusual agencies (e.g. root and moth borers), such stools have not been chosen. It is hoped by such means to raise the correlation coefficients and thus make first year seedling selection as accurate as is possible.

(*d*) SUGAR CANE—2ND YEAR SEEDLINGS.

These seedlings were selected from the 1st year seedlings in (the beginning of) 1929 (multiplied throughout the greater part of that year) and planted in a special trial in November 1929.

There were in all three groups of seedlings to be tested, those selected from early, medium and late reaped cut blocks of first year seedlings for trial as second year seedlings for early, medium and late cutting. All three groups were tried at two plantations, viz. Dodds and Lemon Arbor, which, on the average respectively represent places of low and above average rainfall. At each station and for each reaping time the seedlings were pitted against what were considered for the respective districts the best varieties. The members of each group of tested seedlings together with the selected standard varieties were replicated in each of four randomised blocks. Each plot was of twenty-four cane holes, so that in all any one seedling occupied ninety-six cane holes, or approximately 1/18th acre.

The year 1930 witnessed an exceptionally low rainfall, being respectively over the growing season (Dec. 1929—Jan. 1931) twenty-seven inches at Dodds and forty-nine inches at Lemon Arbor compared with the average of 59 inches at Dodds and 74 inches at Lemon Arbor.

The procedure adopted at reaping and subsequent selection was the same at each place. For each plot the following features were determined (1) weight of sound canes (2) number of sound canes (3) number of rotten canes and (4) percentage sucrose in the juice. The latter was ascertained from juice from eighty pound cane samples from each plot.

Samples of canes were obtained for each seedling for observation on the vegetative features and to provide plants of those seedlings selected for further trial.

The following seedlings showed sufficient promise to be selected for further large scale trials in wet and dry districts:—

	Wet Districts	*Dry Districts*
(i) *Early Group*	B. 2739	B. 2919
	B. 2905	B. 2901
		B. 2739
(ii) *Medium Group*	B. 2931	B. 2935
	B. 2731	B. 2937
	B. 2935	B. 2931
		B. 2947
		B. 2945
		B. 2939
(iii) *Late Group*		B. 2976
		B. 2977

(*e*) SUGAR-CANE VARIETY "MATURITY" EXPERIMENTS.

The object of these experiments is twofold. They are designed to obtain information on the general effects of "place," variety and time of reaping on weight, its contributory factors (number of canes, length and width of canes,

occurrence of rotten canes) and percentage sucrose in the juice for three periods in crop, early, medium and late. They also serve to give information on the responses by Barbados varieties, imported varieties and promising seedlings to place and time of reaping. This information is used in the selection and grouping of parental material in breeding and also assists with planting recommendations for the various parts of the island.

The "lay-out" procedure adopted and stations used in these experiments were the same as in the 1928-30 "maturity" experiments and are being repeated this season. The varieties were, however, in part different. Growth recording is carried out on varieties in plots in these experiments and for this several standard plantation varieties have been and will be measured in future, to study the effect of different seasons on their growth. Thus, several varieties will be retained for several seasons. From time to time other varieties will be introduced (namely those which reach a stage of promise sufficient to recommend them for growing on plantations). To these standard varieties are added imported varieties and promising seedlings.

In the 1929-31 experiment, Vaucluse and Graeme Hall were again planted and their rainfalls are given below:—

RAINFALL AT MATURITY EXPERIMENT STATIONS 1929—31.

	1929			1930										1931			
	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total
Graeme Hall	8.08	3.08	1.23	.45	.19	1.16	.32	2.87	3.48	2.86	2.94	5.05	2.97	3.09	1.64	.32	.48	40.21
Vaucluse	10.99	3.57	2.99	1.10	.34	1.52	.51	4.46	6.46	2.82	5.53	4.46	5.03	4.01	2.52	.99	1.05	58.35

Sixteen varieties were planted, viz. B.H.10(12), Ba.6032, Ba.11569, B.374, B.381, B.417, B.465 (at Graeme Hall only), B.605, B. 726, B. 755, B.891, P.O.J's 36, 826, 2379, 2364 and 2725.

All varieties were randomised in nine hole plots (approximately 1/200th acre) in each of twenty-four blocks.

Three reapings were made (early, medium and late) for each station and, at each reaping, sets of eight blocks were reaped, the three sets of eight blocks at each place being chosen so that they were comparable.

At reaping, all nine stools in each plot were reaped, the canes divided into a, b and c shoots, each shoot group weighed, an average cane for each measured in length and width, an estimation of the number of sound and rotten canes taken, and finally a sample of forty canes, chosen, so that a, b and c, shoots were present in proportion as they occurred in the plot and their sucrose percentage in the juice determined.

The results are presented in diagrammatic form on Plates II and III. Any one determination is the mean figure of eight plots (one from each of the eight blocks cut at any one reaping).

Discussion on the Data.

(1) *Weight of sound canes.* In this feature, as in the trial reaped last year, the yields at Vaucluse are over all varieties, greater than at Graeme Hall. At Graeme Hall weights rose slightly towards mid-crop, then dropped to end of crop. At Vaucluse there was on the average a gradual loss in weight as crop progressed. These average variety yield reactions throughout crop at each place are approximately similar to those in the 1928-30 experiments, except that at Vaucluse, while in the 1928-30 trial the drop in yields was greater between the first and second reapings, in 1929-31, the drop was greater between the second and third reaping. This may be accounted for by the fact that growth was delayed at Vaucluse in the 1929-31 crop, owing to a dry August and September. As a result the canes had not expressed their growth as fully as in the 1929-30 trial and therefore were not so ready to rot.

PLATE 2.

MATURITY EXPERIMENTS.
1929-1931.

WEIGHT of SOUND CANES.

GRAEME HALL

VAUCLUSE.

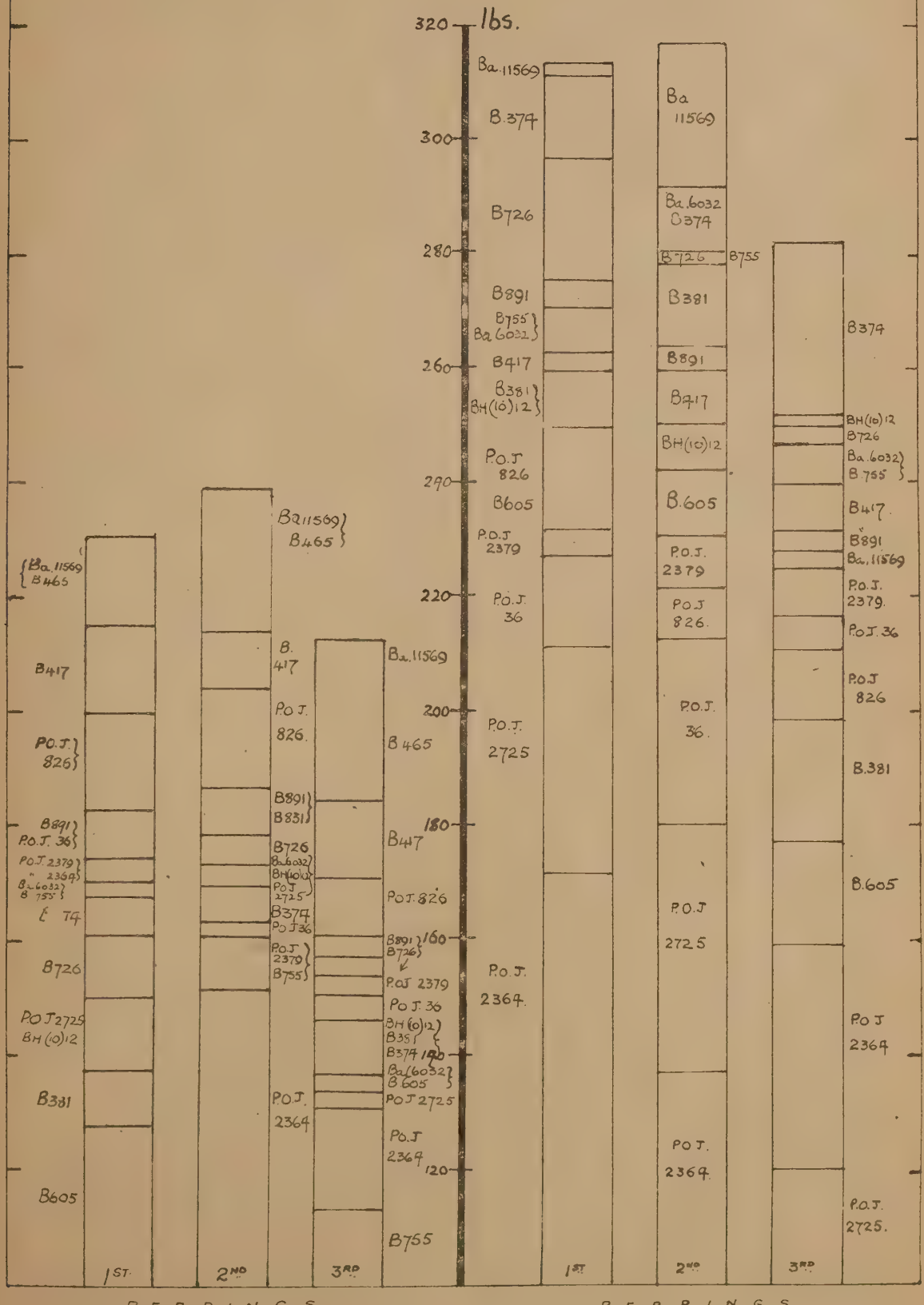
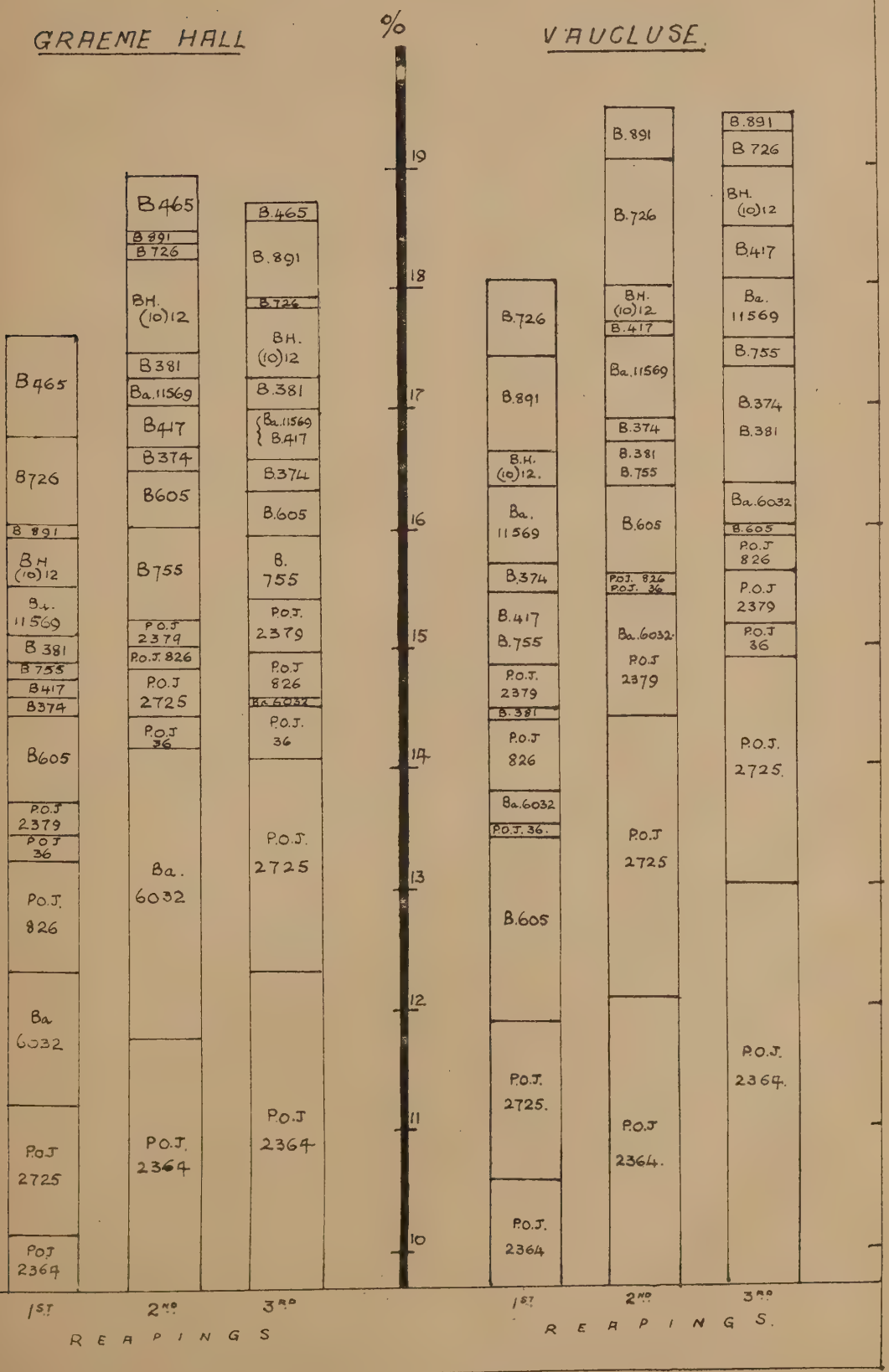


PLATE 3.

MATURITY EXPERIMENTS.

1929-1931.

PERCENTAGE SUCROSE IN JUICE.



The findings in the 1929-31 maturity experiments support the hypothesis put forward previously to explain the general change in weight of all varieties at both places as the crop time progresses, namely that the susceptibility of cane varieties to loss in weight during crop time is directly associated with the stage of maturity which the cane has reached prior to entering the crop season. It is apparent that a well and relatively fully developed crop will rot more readily during the reaping time than a crop which has not yet attained a full growth development. It is significant, in this respect, to note that in the crop which has just been reaped, and in which, for the major part of the island, development was below average, the extent of occurrence of rot was relatively low.

As with the 1928—30 maturity experiments, so this year, for weight during the crop the varieties show differential responses. These are best seen by a study of the relative placings of the varieties at the three reaping times at both places (Plate II). At Vaucluse B.H.10(12) and Ba.11569 illustrate this very well. B.H.10(12) is seen to retain its weight throughout crop, while Ba.11569 drops very heavily between the second and third reaping.

When compared with the Barbados varieties the Java varieties at both places are seen to perform relatively better at the drier station, Graeme Hall—than at Vaucluse. Actually at both places and more especially at Vaucluse they are generally inferior to the Barbados varieties best suited to these places. When to this is added their comparatively poor juices it is seen that none appear to offer promise as varieties for commercial planting.

A notable feature is the low weights of the Java varieties P.O.Js.2364 and 2725. The former, nevertheless, is an excellent weight-endowing parent and such results show the danger of selecting may-be parents from their performances.

Plate II further shows the differential response by varieties in weight to different average crop yields. This is perhaps best seen by the relative placings of the Java and Barbados varieties at Graeme Hall and Vaucluse, and by a study of the relative positions of the Barbados varieties, Ba.11569, B.726, B.H.10(12), B.374 and B.891 at the two places.

(2) *Percentage Sucrose in the Juice.* The data are graphically presented on Plate III. Perhaps the most interesting feature in contrasting the data of 1928—30 with those of 1929—31 occurs at the Graeme Hall reapings. While it appears that the sucrose production in the juice of the canes was earlier this year, it is also apparent that the sucrose in the juice never attained in later reapings to that of the 1928—30 crop at that place. In fact, the sucroses at the second and more especially the third reaping are inferior to those in the previous crop. It is suggested that the following explanation may partially account for this difference between the seasons. The crop in the 1928—30 season at Graeme Hall was the result of a good average growing year. Ripening was a normal and gradual process, whereas the 1929—31 crop was grown under conditions of low moisture and recurring checks. The plants were poorly developed when they entered into the dry crop season. Consequent on this stunting, maturity being hastened never reached the standard of the previous crop and in fact, so far as sucroses were concerned, deteriorated towards the end of crop. In this respect the performances of B.465 and more especially B.891 deserve attention. These varieties while both showing high sucroses at all reapings reveal a welcome tendency to retain that high juice quality, when other varieties such as B.726 and Ba.11569 are going back badly. (The performance of B.465 in weight and sucrose per cent. in the juice is very good indeed and suggests its further trial in normally low-tonnage districts). For the second season it has performed relatively well at Graeme Hall.

The sucroses at Vaucluse show a tendency to increase to the last reaping. In the main this is a repetition of the previous season's trial at that place, except that the sucroses at first reaping are higher in this year's trial and consequently the rise between first and second reaping is not too pronounced. In this respect, Vaucluse in 1929-31 tends to resemble Graeme Hall in 1928-30. Again, as with weight, so with sucrose percentage in the juice, there is a differential response by varieties at both places as crop progresses.

(*f*) SUGAR CANE VARIETY TRIALS 1929-31.

(*i*) *Plant Canes*

Six stations were planted for trial in 1929 at Clifton Hall, Blackmans, Black Bess, Pickerings, Constant and Coverley. The very severe drought during the greater part of the year coupled with the fact that certain plots suffered severely from theft at the last named station, so stunted the crop that it was not worth reaping. The following varieties were planted at all stations—B.H.10 (12), Ba. 11569, B.726, B.891, B.374, B.755, B.663, B.605 and White Transparent. The "lay-out" at each station was the same. All nine varieties were placed at random in each of eight blocks, in forty-two (7 x 6) cane hole plots (approximately 1/40th acre). At each station during crop time two reapings of four blocks each were made; the first was, for any station, an early reaping, while the second was medium—late. Each plot was weighed and a representative bundle of 180 pounds of canes was taken at each reaping for each variety for complete laboratory analysis and the sucrose per acre for every variety was determined for each reaping time at every station.

The results are presented on Plates IV, V and VI.

A study of the yields of varieties in numerous trials has shown that the order of varieties in yielding capacities when several places are compared, tends to be more alike for places where the mean yielding capacities of all varieties approximate. (For example "places" A and B may yield on an average over all varieties 35-40 tons, while "places" C and D may yield 20-25. Now the order of varieties, so far as yield is concerned, tends to be alike for A and B and for C and D, while these orders themselves (i.e. at A or B and at C or D) may differ greatly).

The diagrammatic presentation therefore of the data from the 1929-31 trials was derived by grouping Clifton Hall and Blackmans together as at these stations the average yield over all varieties was approximately 35 tons, while Black Bess, Pickerings and Constant (with an average of approximately 20 tons) formed a second group. Moreover, the order of variety yield merit at the former two stations was approximately alike and differed from that for the varieties at the other three stations and vice versa. It is clearly seen that the order of variety yield between these groups is quite different; (B.726, B.374 and B.H.10(12) excel in Group I, while Ba.11569 is easily first in Group II). It must however be pointed out here that an average tonnage of 20 tons for Group II stations is extremely below normal and the placing of varieties in this Group does not represent their true worth for a normal crop season at these stations, when average yields of 28 tons may be expected. The information gained from the trials in Group II would be of value for places where an average yield over a number of years of approximately 20 tons might be expected but such places in normal years would not be growing sugar and such weather it is hoped will not be experienced again. The yields in the trials for 1929-31 for Group I approximate to the average for these stations.

The relative performances of varieties at early and medium—late reapings are considered to be of great practical importance and the varieties tried in these trials responded differently in yield, sucrose percentage in the juice and consequently sucrose production per acre at these two reaping times. A study of the diagrams will reveal this more clearly. Perhaps the best example is the reactions of B.726 and B.H.10(12) to the different reapings in Group I. B.726 is seen to fall considerably in tonnage at the second reaping, while B.H.10(12) retains its weight. Again while B.726 at first reaping is well in advance of B.H.10(12) in sucrose in the juice, at the second reaping, this difference is not so well pronounced. B.H.10(12) gains on B.726 in this respect as crop progresses, until (as seen from maturity experiments) it draws level.

(*ii*) *1st Ratoons.*

Four first ratoon stations were under trial and at each there were six replications and all varieties were randomised in each replication. Each plot was twenty-five cane holes (approximately 1/70 acre) and at reaping all twenty-five holes were cut and weighed. Sample bundles of 180 pounds (30

PLATE 4.

VARIETY TRIALS - PLANT CANES

Sucrose in Pounds Per Acre.

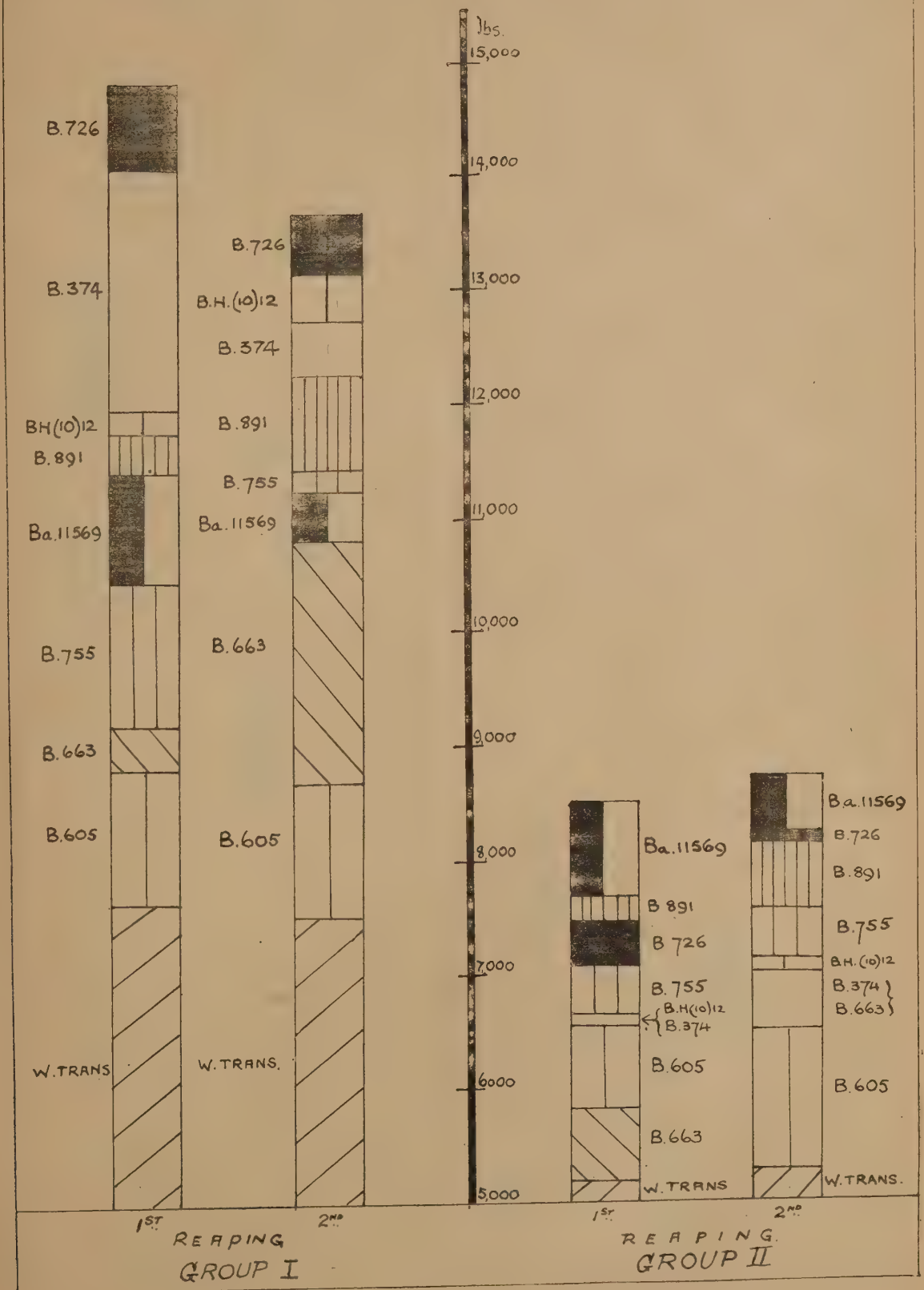


PLATE 5

VARIETY TRIALS - PLANT CANES.

Tons Per Acre.

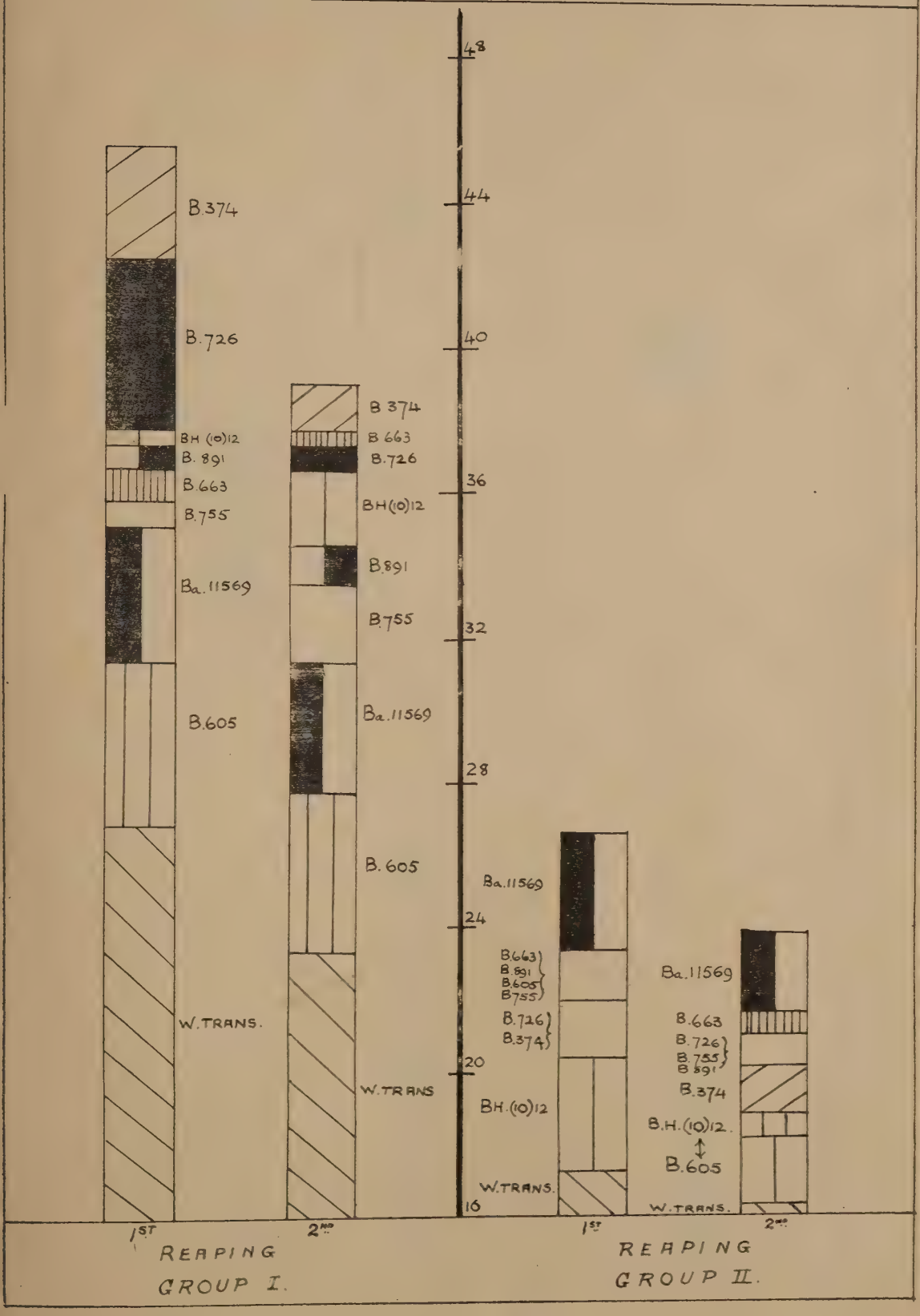
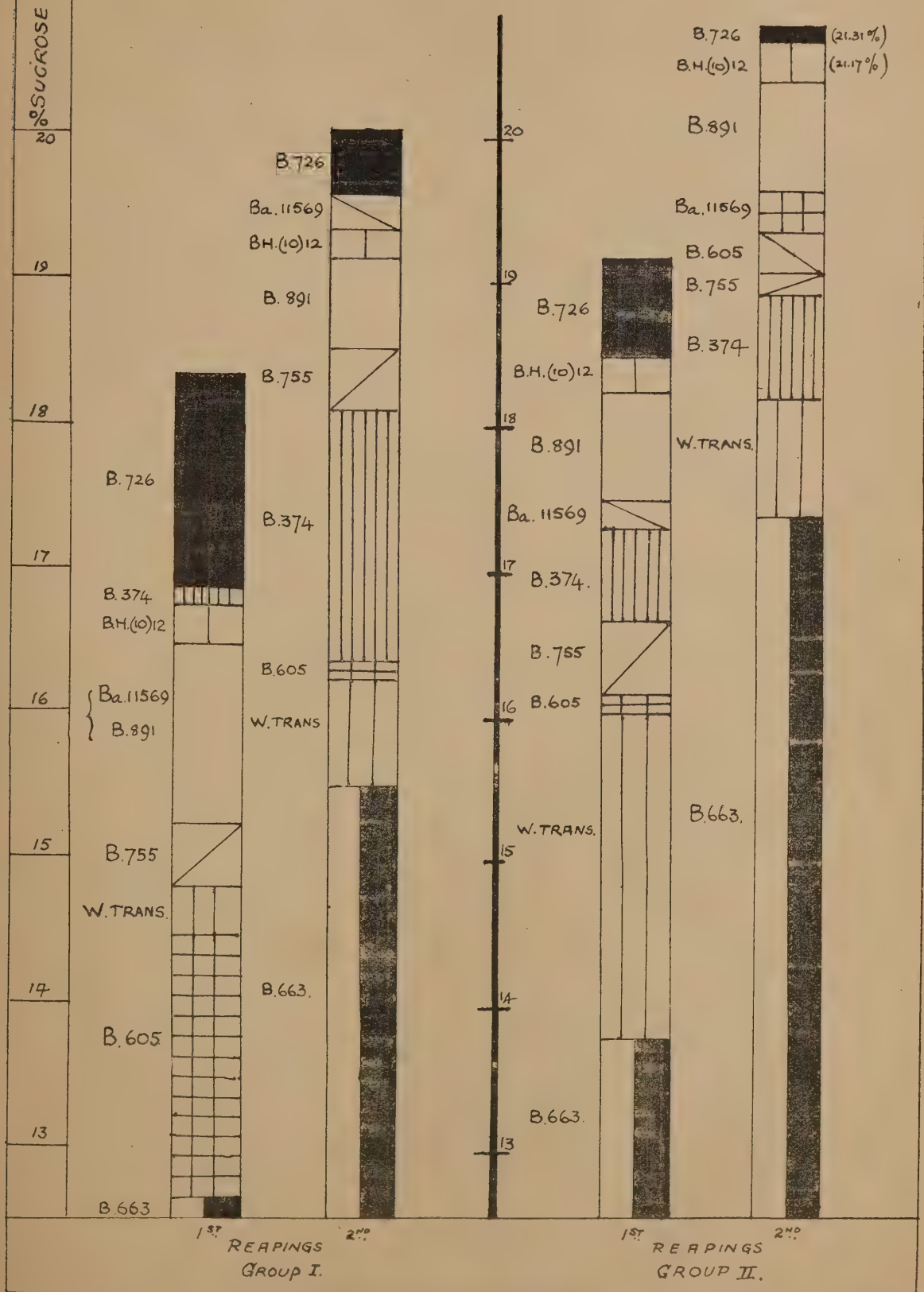


PLATE 6.

VARIETY TRIALS - PLANT CANES.

% SUCROSE IN JUICE.



pounds per plot) of canes were used for sucrose percentage determinations.

The stations were Clifton Hall and Blackmans, Mount Wilton and Ridgeway. One series of varieties was grown at Clifton Hall and Blackmans and another series at Mount Wilton and Ridgeway. The Clifton Hall and Blackmans yields approximated and the variety merit list in this respect was almost similar at both places. In presenting the data, therefore, these two stations were grouped together. The yields at Mount Wilton and Ridgeway differed appreciably as did also the order of varieties in yielding capacity. These stations were not therefore treated together, but are considered separately (Plate VII).

The feature of altered orders of varieties in yielding capacities under conditions promoting different tonnages, occurs also in the first ratoon trials and supports the discussion in the plant cane variety trials.

(*g*) Sugar Cane:—*Experiment to Observe Relative Varietal Resistances to Gumming Disease.* (*Bacterium vascularum* (*Cobb*) (*Greig-Smith*).

Introduction:—Disease leaf symptoms suspected to be those of Gumming Disease were first noted in Barbados on Ba.11569 about July 1929 in the parish of St. Lucy. These suspicions were confirmed later by Prof. Briton-Jones of the Imperial College of Tropical Agriculture, Trinidad, who examined diseased plants in the field. At that time it was thought that the disease was localised in the parish of St. Lucy and the north of St. Peter. Observations were made at the time on the extent of appearance of leaf symptoms on promising varieties planted in small lots in this heavily diseased area where Ba.11569—obviously highly susceptible when judged by the extent of development of leaf symptoms—was universally planted. Judged by these leaf symptoms it was ascertained that varieties B.417 and B374 appeared to show high resistance. Now it appeared from a study of the literature on this disease that the damage resulting to the plant by the disease on the leaves was negligible, but that great losses might be sustained by the development of the disease in the conducting strands in the canes, where a bacterial slime is produced which chokes these water carrying vessels, causing stunting in the plant and interfering with crystallisation in the factory. This serious form of the disease may be designated as "true" gumming.

At the time of the confirmation of the presence of this suspected disease no true gumming in the canes was observed, and it was a question whether this latter and acute form of the trouble would ultimately assert itself and create serious losses in a district almost entirely devoted to the planting of the susceptible variety Ba.11569. The differences in disease expression between the leaf symptoms form (for convenience called the mild form) and those found in the true gumming were held by some to be due to the existence of mild and virulent strains of the organism and by others as differences due to the environmental conditions surrounding the plants; and if either supposition were correct there was always a possibility of the virulent form eventuating. The Department therefore advised a restriction of the acreage of the susceptible Ba.11569 variety and its substitution in part by B.417 and B.374 in the affected areas.

In the crop season of 1930, no definite cases of gum exudations were recorded, nor, in spite of the spread of the mild form over a large part of the island, have such symptoms been seen throughout 1930 or in the crop season of 1931, but the "mild" form has persisted and spread.

Judging by yield returns and the observations of the Department and planters, this mild form of the disease does not appear to cause diminution of the yield and perhaps in this respect may be no more harmful in Barbados than Eye Spot disease.

A trial was conducted to determine the relative resistances—as judged by leaf symptom developments—of a number of sugar cane varieties. Included in the latter were (a) standard plantation varieties, Ba.11569, B.H.10(12), (b) varieties recommended by virtue of their showing high resistance to gumming disease, B.417 and B.374 (c) recently recommended varieties B.726 and B.891 (d) varieties grown on some plantations on a small scale, Ba.6032, B.606, B.381, (e) varieties of promise or in use as parent plants, B.755 B.663 and B.391 and (f) imported varieties, P.O.J.'s 36, 213, 2364, Co. 213 and Uba. The varieties in the latter category are mainly used as parent plants in breeding.

All of these varieties were randomised in three hole plots each in each of thirty rows; these latter alternating with rows of 1st ratoons of Ba.11569 whose plant canes had been heavily attacked with gumming disease. The rows were at right angles to the direction of the prevailing wind to allow ease of infection. The ratoon Ba.11569 plants eventually showed pronounced gumming symptoms on their leaves and apparently acted as ideal media for infection of the tested plants.

Two examinations were made during the crop season of 1931, viz on 26th February and 23rd March. (The latter was made in case symptoms should appear on some varieties only under conditions of severe drought. This did not appear to be the case and the results of the latter examination served to confirm the former).

The presence of the disease was noted by leaf symptoms only and the intensity of infection on any one plant noted arbitrarily by assigning so many plus signs according to the extent of leaf area covered by disease marks. Finally, for all varieties, the average was taken over the number of rows observed.

As a result of these observations the following classification was made.

Leaf Symptoms.	Variety.
1. Leaf Symptoms not seen	Uba, P.O.J.213, P.O.J.36 and P.O.J.2364 *
2. Leaf symptoms very little in evidence and then only at leaf tips ..	B.H.10(12), B.891, B.417, Co.213 and B.391.
3. Leaf symptoms little in evidence ..	B.374.
4. Leaf symptoms quite evident although not present in great amount	B.755, B.606.
5. Leaf symptoms pronounced ..	B.726.
6. Leaf symptoms very pronounced ..	Ba.11569, Ba.6032, B.381, B.663.

(*h*) SUGAR CANE SPACING EXPERIMENT.

In the Annual Report of this Department 1929-30, page 41, an introductory account was given of a preliminary spacing experiment. Three spacings were employed and the growth response—as represented by tonnage of cane obtained—of three varieties of different growth habits was ascertained. Each variety was grown at each of the three spacings and a variety at any one spacing was considered as the unit ("treatment"). Thus, there were nine treatments and all nine were randomised in each of four blocks. It was hoped to ascertain in this way for the particular conditions of the experiment, the effect of different spacings and varieties on the tonnage obtained and the differential response, if any, of the varieties to the different spacings. As an additional inquiry, the effects of spacings and varieties on sucrose percentage were also determined.

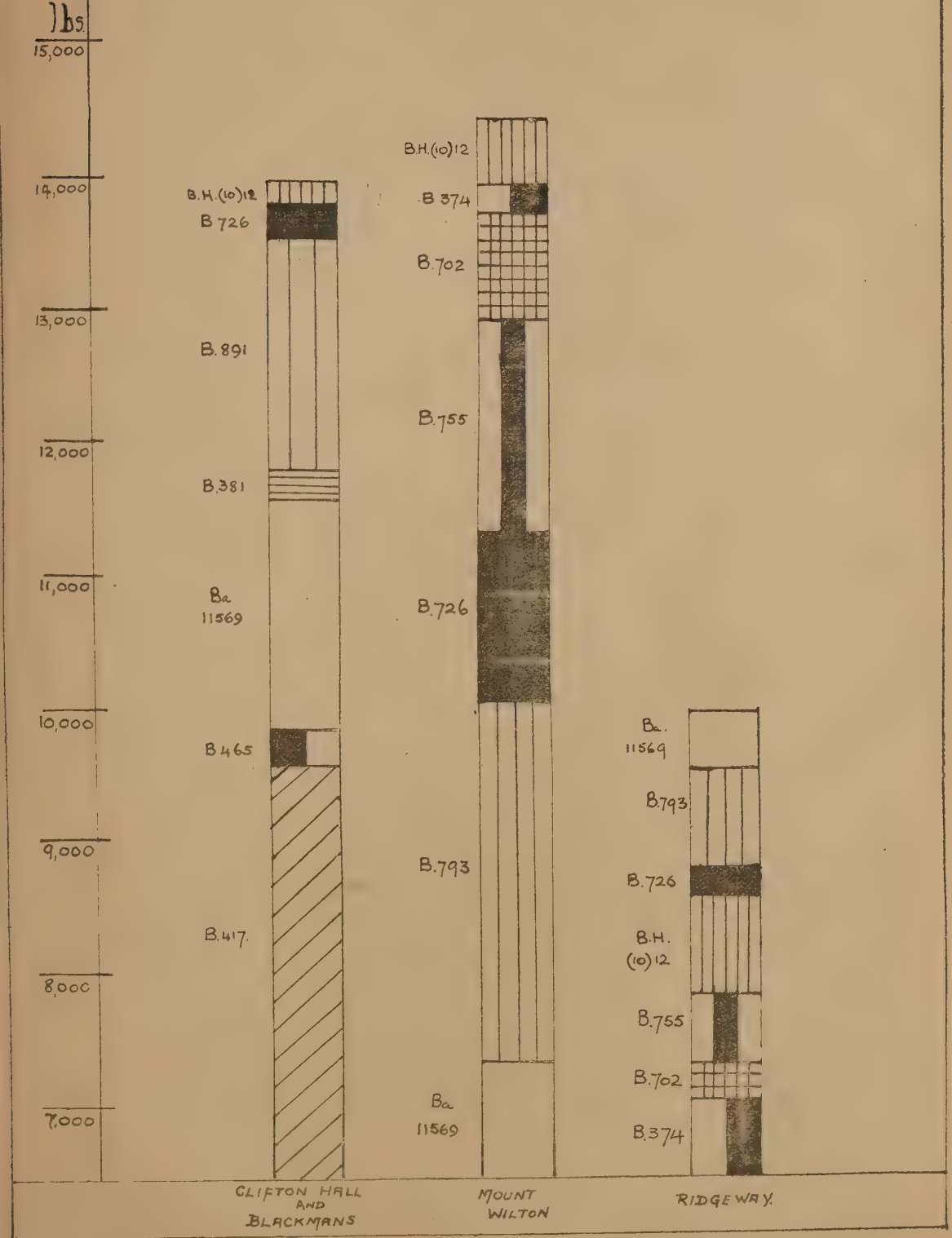
Owing to an escape of water from irrigation gutters nearby, it was necessary to eliminate five plots. Because of this no analysis of variance was employed and no information could be obtained on the existence of a differential response by varieties in tonnage and sugar in the juice. However, the effect of spacing on tonnage and sucrose in the juice was determined by employing Student's method and comparing within blocks, yields and sucroses in the juices of the

*Suspicious pale stripes were seen on P.O.J.2364, but it could not be definitely said whether these were gumming symptoms peculiar to this variety, or symptoms of some quite distinct abnormality. The latter view appeared to be probable.

PLATE 7.

VARIETY TRIALS. 1ST RATOONS

SUCROSE IN POUNDS PER ACRE.



same variety grown at different spacings. This was done for all three varieties over the four blocks.

The results are given in the following tables:—

TABLE X.

SUGAR CANE SPACING EXPERIMENT: CODRINGTON 1929–31.

Yields of cane from differently spaced plots of approximately 1/70 acre.

Variety.	Block.	Spacing between plants and yield lb.		
		5′ x 6′	5′ x 5′	5′ x 2½′ *
B.605 ..	1	742	759	942
	2	510	..	768
	3	..	..	800
	4	715	896	808
B.726 ..	1	681	690	734
	2	..	631	691
	3	625	535	718
	4	676	673	732
B.891 ..	1	725	..	860
	2	618	593	936
	3	620	650	757
	4	610	630	753

A summary of the above results is presented in tabular form below:—

Spacing and Mean Yield per 1/70 acre plot—lb		Diffrence in favour of:—	Comparisons. No.
6′ x 5′	5′ x 5′	5′ x 5′ over 6′ x 5′	
661.0 (20.7). (1)	678.4 (21.2)	17.4 ± 25.3 (0.5)	8
6′ x 5′	5′ x 2½′	5′ x 2½′ over 6′ x 5′	
652.2 (20.4)	800.8 (25.0)	148.6 ± 26.0(2) (4.6)	10
5′ x 5′	5′ x 2½′	5′ x 2½′ over 5′ x 5′	
673.0 (21.0)	785.7 (24.6)	112.7 ± 33.8(2) (3.6)	9

(1) Numbers in brackets under plot averages are computations of tons per acre made from these.

(2) These differences are statistically significant.

* At this spacing cane holes were dug in rows five feet apart and at two and one-half feet apart in the rows.

TABLE XI.

SUGAR CANE SPACING EXPERIMENT—CODRINGTON 1929–31.

Percentage sucrose in juices of 120 lb. samples of cane from differently spaced plots of approximately 1/70 acre.

Variety.	Block.	Spacing and Sucrose Percentage in juice.		
		6′ x 5′	5′ x 5′	5′ x 2½′
B.605 ..	1	14.95	15.12	15.19
	2	15.21	..	15.93
	3	..	..	15.39
	4	15.03	15.75	16.19
B.726 ..	1	17.59	18.88	18.70
	2	..	18.01	18.29
	3	17.92	18.29	18.89
	4	18.73	18.34	17.50
B.891 ..	1	18.06	..	18.58
	2	18.13	18.41	18.33
	3	17.70	18.40	18.76
	4	17.70	18.11	18.84

A summary of the above data is presented below:—

Spacing and Mean sucrose percentage in juice per plot.		Difference in favour of:—	No. of Comparisons
6′ x 5′	5′ x 5′	5′ x 5′ over 6′ x 5′	
17.660	17.176	0.484 ± 0.162 (1)	8
6′ x 5′	5 x 2½′	5′ x 2½′ over 6′ x 5′	
17.102	17.688	0.586 ± 0.221 (1)	10
5′ x 5′	5 x 2½′	5′ x 2½′ over 5′ x 5′	
17.701	17.857	0.156 ± 0.150	9

(1) These differences are statistically significant.

Under the conditions of the experiment, it is seen that the 5′ x 2½′ spacing outyielded the 6′ x 5′ and 5′ x 5′ spacings by 20% and 16% respectively. The closer spaced plants gave a significantly higher sucrose percentage in the juice at time of reaping (2nd February) than the 6′ x 5′ spaced plants.

This experiment might suggest a possible method of increasing tonnages and juice qualities, the latter more especially for an earlier reaping.

It is realised that other factors will of necessity interact with yields and juice qualities besides that of spacings employed. The time of reaping may possibly have a considerable effect and here it is possible that greatest advantage of a closer spacing would be obtained in an early reaping, since rot might start earlier and be more considerable in closer spaced plants, while the juice qualities might be expected to deteriorate more quickly throughout the crop.

Two further and larger spacing experiments have been planted for reaping in 1932. These have been placed in higher and lower tonnage districts. A fourth spacing has been added, viz., five feet between furrows in which the canes have been planted continuously. The "lay-outs" employed are similar at both places and are essentially the same as used in the above experiment and in these as in the first experiment all plots receive the same amount of manure whatever the spacing.

(*k*) SUGAR CANE CUTTING BACK EXPERIMENT.

Introduction: From data accumulated during a series of growth measurements, it appeared that stools of sugar cane grown in the districts of higher rainfall tended to have fewer shoots throughout the growing season than those in the drier districts and as a result at crop time fewer canes per stool. These canes although fewer generally weighed heavier and so per acre equalled and surpassed the yield of the canes from the drier area. It was considered that by cutting back the stools in the rainier districts at the commencement of the rains and thereby encouraging an extra shoot production, these stools might yield heavier than those allowed to develop normally; this on the assumption that under higher rainfalls the greater number of shoots would individually develop as fully as those in stools which had not been cut back.

Again, it was considered that varieties might respond differently to such cutting back, according as they tended to produce a greater (e.g. B.726) or fewer (e.g. B.H. 10 (12) number of shoots up to the commencement of the rains. It was felt that the lower shoot producing variety would respond, if at all, greater to such treatment.

Experiments were carried out at Lemon Arbor plantation. The rainfall during 1930—31 at this station is given here:—1930 January 3.00 (inches), February, 1.27; March, 0.87; April, 2.89; May, 1.26; June, 5.52; July, 6.20; August, 2.88; September, 5.73; October, 5.06; November, 6.63; December, 4.81; 1931. January, 2.94; total for thirteen months 45.52 inches. Crops of B.726 and B.H.10(12) were experimented with. These were fields of plantation canes grown under ordinary plantation conditions.

(1) B.726. In this variety seventeen comparable pairs of plots of forty cane holes each—(approximately 1/44 acre)—were considered. One lot (lot B) were cut back flush with the soil level, while the others, adjoining them (Student's system of pairing) were untouched. (The cut shoots provided fodder at a time when it is generally very scarce). Countings of shoots were made immediately before cutting back and three months after cutting back and finally cane counts were made and weights were taken at crop time.

(2) B.H.10(12). The treatment was identical here as with the above variety. There were here, however, ten comparable pairs and each plot comprised ninety stools (approximately 1/20 acre).

The following results were obtained at reaping:—

(a) B.726.

The results showed an increased number of canes in the cut-back plots but a diminished yield (compared with those not cut-back) of 8.11 tons per acre (or 19.6%).

(b) B.H.10(12).

There was an increased number of canes in the cut-back plots but a drop in yield (compared with those not cut-back) of 1.88 tons per acre (or 5.8%).

Discussion. When considering these results, the rainfall at Lemon Arbor for 1930 must be considered. While the rainfall up to and including July might be said to be fairly up to average for that plantation, the subsequent rains for August, September, October, November and December were much below average more especially the August rainfall. This fact tended to diminish the value of the experiment. The cutting back was done in that plantation representing a district where rains are plentiful during these months, and in the hope that the anticipated extra shoots developed would be sustained in a development as great as that in the individual canes of the non cut-back stools. Taking the results in this experiment, it was found that cutting back increased significantly the number of shoots per stool by 50% in B.H.10(12) and 90% in B.726 when counted in September. It is likely that the low rains in the critical period of August and September severely checked development of those shoots and many died with the result that at crop time, there was little or no difference in the number of canes in cut-back and non cut-back plots.

It is of interest to note that, in a variety such as B.H.10(12) where shoot production is slow, cutting back did not lower the yields so much as in an earlier shoot producing variety such as B.726.

This experiment suggests that cutting back is not a method of increasing yields unless there follows a plentiful precipitation.

Since, however, in this experiment the rainfall was much below average it is being repeated this year.

SECTION II.—SWEET POTATO.

INTRODUCTION.

The object in this work is to introduce new varieties, or to breed seedlings of the sweet potato:—

(*a*) with increased yields;
(*b*) with good storage qualities;
(*c*) suitable for export (i) to Canada;
(ii) to other West Indian Islands.
(*d*) with early maturity for the scarabee areas and for catch crops.

The results of this work for the last year are best considered under the heads:—

(1) Variety trials, and
(2) Sweet Potato Seedlings Trials.

(1) VARIETY TRIALS "CATCH" CROP.

This so-called "catch" crop in the island is grown from the first rains (June or July) until October. It is then reaped to allow sugar cane planting in the same field in November. On an average, it occupies the ground for around sixteen weeks.

Here it is desirable to obtain early or quick bearing varieties, with, if possible, high yielding powers. In scarabee free lands, it is also desirable that good keeping may be added to the above qualities. This allows for storage locally or export, at a time when the sweet potato supply tends to be in excess of local demand.

Two catch crop variety trials were carried out.

(*i*) CATCH CROP AT DODDS.

Seven varieties were tested. These included two local varieties which are considered to be the best catch croppers—Six Weeks and Red Nut. Both are, however, poor keepers under ordinary methods of handling in digging and transport.

It was considered desirable to test promising imported plants with them—Brook's Seedling No. 3, Brooks Gem and V.52. Trinidadian (syn. Black Rock) was also included, for reasons that it is commonly planted for this crop, chiefly owing to its good keeping qualities and its consequent suitability for shipping. St. Joseph Water Hole, a local variety, completed the number in the trial, its inclusion being due to its good performance in 1929.

All varieties were randomised in each of four blocks. Each plot was sixty cane holes (approximately 1/29 acre) and three hills per hole were planted. The "take" was very good and little supplying was necessary. Planting was done on the 26th June, 1930, and digging on the 13th October—over all a period of approximately sixteen weeks.

At digging the following features were noted:—

SWEET POTATO VARIETY CATCH CROP TRIAL. DODDS 1930.

EACH FIGURE IS THE MEAN OF FOUR PLOTS.

Variety.	Potatoes.				Vine
	Yield lb.	Number	* Percentage Scarabee attack by weight.	Yield of Scarabee free lb.	Yield lb.
Six Weeks	196.5	408	46	107.5	169.0
Red Nut	192.0	392	41	116.8	255.0
Brook's Seedling No. 3 ..	164.0	410	26	123.0	242.5
St. Joseph Water Hole ..	163.5	464	32	108.0	251.7
Brook's Gem	136.3	448	44	75.8	194.8
V. 52	120.3	311	35	98.3	240.5
Trinidadian	78.0	298	26	59.5	287.0
A significant difference between variety means ..	±35.80	..	± 13.65	± 32.59	± 33.96

(*ii*) CATCH CROP AT WATERFORD.

This was a general variety catch crop trial and included local and imported varieties.

There were in all fifteen varieties. All were randomised in each of four blocks. Each plot contained fifty-six cane holes, (approximately 1/30 acre) and slips were planted in three hills to the hole. The plants were planted on 14th July and digging was done on 6th November—a growing period of fifteen weeks.

The field results are presented in the following Table.

* This was determined for any one plot by dividing the tubers into scarbeed and non-scarabeed and weighing each group and estimating the percentage occurrence by weight of the former.

SWEET POTATO VARIETY "CATCH" CROP TRIAL. WATERFORD 1930.

EACH FIGURE IS THE MEAN OF FOUR PLOTS.

	Potatoes.				Vine.	
Variety.	Place of Origin.	Yield lb	Percentage scarabee attack by weight.	Yield of scarabee free lb	Yield lb	Statistical Note.
Six Weeks ...	Barbados	331·2	34·9	244·3	231	A difference for yield of potatoes between the means of four plots of ± 105·0 lb. or more may be regarded as significant.
Philippine Seedling No. 3.	Philippines	286·0	16·8	234·2	442	
Purple Stem Six Weeks ...	Barbados	280·3	19·6	220·0	234	
V. 52	St Vincent	263·8	3·2	255·2	439	
Red Nut ...	Barbados	253·3	4·1	242·0	346	
Brooks eedling No. 3	Queensland	233·5	4·6	223·0	349	
Caroline Lea ...	Barbados	214·0	7·3	198·0	327	
St. Joseph .. Water Hole ...	Barbados	206·5	3·0	200·0	376	
Philippine Seedling No. 2 ...	Philippines	199·3	2·8	193·8	472	
Brooks Gem ...	Queensland	172·5	2·5	166·0	359	
Philippine Seedling No. 1 ...	Philippines	158·0	4·2	150·2	425	
White Gilkes ...	Barbados	150·3	0·6	149·0	444	
Brooks Seedling No. 29	Queensland	125·5	3·1	122·0	338	
Trinidadian ...	Barbados	104·0	0·0	104·0	376	
Brooks Seedling No. 6	Queensland	103·5	9·6	88·5	252	

Samples of scarabee-free potatoes were put into storage crates placed in a cool and well ventilated position. Notes were periodically made on rat, mice and bird attack, softening, rotting and sprouting, during a three month storage time. The following notes give a general summary of these observations.

Six Weeks and Purple Stem Six Weeks were so badly attacked by birds and mice that it was impossible to note how they fared in other storage features. (These varieties along with Caroline Lea appear to be very susceptible to such destruction.

Caroline Lea and St. Joseph Water Hole rotted badly and suggest complete uselessness as varieties for storing.

Brooks Seedling No. 29 showed considerable rot. Red Nut showed a slight rotting.

The Philippine seedlings showed very little sprouting but there was a suggestion of softening in each and a little rot.

Trinidadian, White Gilkes and Brooks Gem sprouted heavily, but, nevertheless appeared quite sound.

V.52 and Brooks Seedling No. 3 performed best in storage. Sprouting was little in evidence and the potatoes appeared to be in excellent condition throughout the storage period.

As a result of the above trials the following varieties have been retained for a further catch crop trial and storage test:—

Six Weeks, Red Nut, Caroline Lea, Brooks Gem, Brooks Seedlings Nos. 3 and 29, V.52, Philippine Seedlings No. 1, 2 and 3.

To these have been added, Mauritius varieties Nos. 1 and 2, Pumpkin Yam and eleven 3rd year selected sweet potato seedlings.

(ii) "LONG" CROP VARIETY TRIAL.

The number of varieties in this trial was increased to sixteen by a re-inclusion of the variety Southern Queen; this on account of its excellent cooking qualities. Planting was done at Guinea plantation on 3rd November 1930 and digging on 5th May 1931—in all a growing period of 26 weeks. The sixteen varieties were randomised in each of four blocks. Each plot contained fifty-six cane holes (approximately 1/31 acre) and slips were planted two to a hill in each of three hills to each hole. At digging notes were taken for each plot on the habit and weight of the vines, the yield, number, mode and depth of bearing, and size and shape uniformities of the potatoes. The following table shows the quantitative data obtained.

SWEET POTATO "LONG" CROP VARIETY TRIAL.—GUINEA PLANTATION. 1930—31.

Variety.	Potatoes.			Vine.	Statistical note.
	Mean weight per 56 cane hole plot. lb.	Mean number of potatoes per 56 cane hole plot.	Computed mean weight of single tuber. lb.	Mean weight per 56 cane hole plot. lb.	
Six Weeks	439	472	0.930	193	
Purple Stem Six Weeks ..	434	563	0.770	161	
Brooks Seedling No. 3 ..	403	641	0.629	220	There was a significant effect of variety on yield.
V. 52	396	466	0.850	234	
Brooks Gem	366	850	0.431	161	
Red Nut	349	514	0.679	236	
St. Joseph Water Hole ..	335	484	0.692	182	
Caroline Lea	312	672	0.465	215	A difference of ± 71 pounds or more may be regarded as significant.
Brooks Seedling No. 29 ..	302	417	0.724	150	
Southern Queen	252	543	0.466	178	
Trinidadian	250	457	0.547	216	
White Gilkes	236	442	0.534	206	
Brooks Seedling No. 6 ..	227	336	0.676	206	
Philippine Seedling No. 3	218	293	0.746	259	
„ „ No. 1	205	313	0.655	220	
„ „ No. 2	202	299	0.676	266	

The following is a short summary of the characters of each variety. The information for each has been gained for the most part from several field, cooking and storage trials. (Storage was effected in lathe work crates in a sun-sheltered well ventilated enclosure and only *sound* potatoes were used. The temperatures, although not recorded in the vicinity of the storage crates must have approximated to those recorded in a nearby screen at the Codrington Meteorological Station. The extremes were around 70°F.—88°F. while the mean centred around 80°F. While these conditions seem to accord well with those advocated in the literature for a preliminary curing period, the temperature for prolonged storage was high. In this respect temperatures of about 60°F.—65°F. are recommended). Under the conditions of the experiment (although rather high temperature and where only non-injured potatoes are used) it is considered that

storage data made on each variety with respect to bird and mice attack, softening, dry and wet rot, sprouting, indicate the relative values of the varieties in keeping ability and showed aid in selection of varieties for keeping in storage locally or during transportation, where less favourable conditions would probably be encountered.

The varieties are described below and are grouped according to their country of origin.

BARBADOS.

Six Weeks and Purple Stem Six Weeks.

These two varieties are considered together since both are considered sufficiently alike in their economic characteristics.

Vine, bush like, giving low weight. Potatoes, pink, bunched, borne near the surface and protruding, large fairly uniform in shape and uniform size, giving very high yields. Cooking quality very good. Keeping ability very bad.

General. This variety gives a low yield of vine but a high yield of potatoes of good eating quality. It does not appear suited to storage or export. The yield might be increased by closer planting. Owing to the bunched mode of bearing the potatoes are easily and quickly dug. Much damage is done by birds and mice to those potatoes which protrude above ground to some extent. A desirable type for good yield of potatoes in a short time where potatoes are to be sold for immediate consumption.

Trinidadian (syn. Black Rock).

Vine, spreading, giving a fairly good yield of fodder. Potatoes, deep purplish-red, bunched and spreading, borne at medium depth, medium size, uniform in shape and size; yield low. Cooking quality very good. Keeping ability excellent.

General. This variety is chiefly grown on account of its good keeping qualities, which render it suitable for export. Its yields however are on the average poor, and it is difficult to dig. Endeavours are being made to obtain a variety with the good features of this one, but with higher yields and greater ease of digging.

Red Nut.

Vine, at first bush, then spreading giving a good yield of fodder. Potatoes, brick red, bunched, with slight spreading tendency, borne near the surface, irregular shape and fairly uniform size, giving good yield; cooking quality good, keeping ability mediocre.

General. This variety is grown extensively. Its irregularly shaped potatoes and mediocre keeping ability do not appear to make it a desirable export type and it should serve chiefly to yield potatos for immediate consumption.

St. Joseph Water Hole.

Vine, bush, then spreading giving low yield of fodder. Potatoes white, bunched and spread, borne at varying depths, uniform shape and size, giving medium yields; cooking quality poor, keeping ability bad.

General. This variety was retained in the variety trials chiefly on account of its performance at Applewhaites in 1929-30. It will now be discarded.

Bequia.

This variety was discarded on account of very low yields.

Caroline Lea.

Vine, bush, and spreading, giving fairly good yield of fodder. Potatoes, skin golden and flesh golden yellow, bunched with slight tendency to spread, borne near the surface, uniform size and shape, medium yield; cooking quality —taste unique, keeping quality poor.

General. This potato tends to crack badly. Owing to its poor keeping qualities it is not suited to storage and consequently export. Owing to its medium yield and peculiar flavour, it is not a plantation potato, but is very popular as a garden potato.

Orange Hill.

Collected in 1928, but discarded owing to its mediocre yield and poor cooking qualities.

White Sealy.

Collected in 1928, but discarded owing to its poor yield and poor cooking qualities.

Bourbon.

Collected in 1928, but discarded owing to its rambling habit rendering digging difficult, and its very late and poor yielding ability. Its cooking quality is, however, excellent and for this reason it is grown in gardens for private use.

White Gilkes.

Vine bush then spreading, giving good yield of fodder. Potatoes white, bunched and spread, medium to deep in bearing, uniform size and shape, medium to poor yield; cooking quality mediocre; keeping ability good.

General. This variety is not so popular as formerly as it yields slowly, is very difficult to dig and gives only mediocre yields. It keeps well in the ground, however, and in crate storage. It cannot be considered worthy of extended growing.

ST. KITTS.

Todds and Hug-me-Tight.

These two varieties were imported in 1929, but were discarded owing to their very low yielding capacities.

ST. VINCENT.

v. 52.

This variety was imported early in 1929.

Vine, spreading, giving a very high yield of fodder. Potatoes, white bunched and spread, borne at varying depths from surface to deep, large, irregular in shape and fairly uniform size, giving good to very good yields; cooking quality good; keeping ability very good.

General. The irregular shape of this potato is, perhaps, its only undesirable feature otherwise it might prove to be very suited for growth and export. It appears to be, apart from shape, well suited for trial shipments. This variety will be more fully tried.

AUSTRALIA.

Five Queensland varieties were imported into Barbados at the beginning of 1929. All were seedlings bred and selected by G. B. Brooks, Esq.

Brooks Seedling No. 60.

This was discarded owing to poor yielding and cooking quality.

Brooks Seedling No. 6.

This seedling has been discarded owing to its mediocre yield, poor keeping qualities and very bad appearance of the potatoes.

Brooks Seedling No. 3.

Vine, spreading, giving fairly good yield of fodder. Potatoes, white, bunched and spread, borne at medium depth, fairly uniform in shape and size, giving high yields; cooking quality good; keeping ability in crate storage very good.

General. This is the most promising of those Brooks seedlings imported into Barbados and may serve to give good yields of exportable potatoes. This variety will be subject to further investigation.

Brooks Gem.

Vine, bush, giving low yield of fodder. Potatoes white, very bunched, borne near the surface, very uniform in shape and size, size small, giving medium yields; cooking quality good; keeping ability in crate storage good, although like Trinidadian it tends to sprout in storage.

General. Owing to the very bunched and surface mode of bearing, these potatoes are exceedingly easy to dig. The potatoes although small, are very smooth and of very uniform spindle shape and very uniform size. They may be readily acceptable in a northern market and trial shipments will be made with them. Its medium yield is its only undesirable feature, but it is considered that this could be overcome by a closer spacing of the plants. This variety will be further tried.

Brooks Seedling No. 29.

This variety appears to be only medium in all its performances and may be discarded.

UNITED STATES OF AMERICA.

Yellow Jersey, Nancy Hall, Pumpkin Yam and Southern Queen.

These varieties were imported in 1928. The first three were discarded, chiefly owing to their poor yielding capacities. Southern Queen was retained.

Southern Queen.

Vine, bunch and spreading giving low yield of fodder. Potatoes white, for the most part, bunched and borne at a medium depth, small, uniform in size and shape, giving mediocre yields; cooking quality excellent.

General. Nothing is known of its keeping ability. Owing to the size of the tubers and the fact that this variety is grown to a large extent in the States, it may, provided it stores well, provide a suitable potato for export purposes. This variety will be tried further.

PHILIPPINE ISLANDS.

Three varieties were received from the Philippine Islands in 1930. All tend to be alike and may be included under one description.

Vines, spreading, giving high yield of fodder. Potatoes, greyish brown, suffused with pink, spreading and borne deep in the ground, soft, large, uniform size and shape, yielding poorly; cooking quality good; in crate storage tend to soften.

General. These potatoes are extremely difficult to dig and in view of their low yields and tendency to soften readily do not show promise. They will be given another trial.

(2) SWEET POTATO SEEDLING TRIALS.

The method consisted in growing seedlings and selecting a certain number, chiefly on abilities to produce potatoes and on the appearance of the latter. Having obtained a workable number, the numbers were tried in small sized plots under "catch" crop and "long" crop conditions. As a result the "catch"

crop number was reduced to thirty, but in the "long" crop trial, owing to caterpillar attack the trial for a second weeding out of seedlings had to be abandoned and this necessitated its repetition this year.

(1) SWEET POTATO SEEDLING CATCH CROP TRIAL.

This trial comprised thirty selected second year seedlings, together with Red Nut—one of the standard local catch crop varieties—as check variety. All were randomised in each of four blocks. The plot size was thirty-six cane holes (approximately 1/48 acre). The plots were planted on August 19th, 1930, and dug on December 4th, 1930—in all a growing period of fifteen weeks. As each plot was lifted notes were taken on (1) mode of bearing and (2) depth of bearing and the following quantitative data ascertained, (3) yield of potatoes and (4) number of potatoes. A sample of each seedling was taken to the Experimental Station, while a sample of the best field performers was sent to the Laboratory for cooking tests. With the field, station and cooking features ascertained for each, eleven were finally selected.

The following table summarises the yields of the most successful seedlings.

SWEET POTATO SEEDLINGS IN CATCH CROP TRIAL.
CODRINGTON 1930.

Mean Yield per Plot of Seedlings.

Seedling.	Mean Yield per Plot. lb.	Statistical Note.
C (s) 305 ..	101 *	
C (s) 128 ..	99 *	
A (s) 15 ..	89 *	There was a significant effect of seedlings on yield.
Y (s) 5 ..	70	
C (s) 94 ..	62 *	
C (s) 372 ..	60 *	
Red Nut ..	55	A difference between any two seedling mean weights of four plots of ± 31.70 lb. or more may be regarded as significant.
C (s) 141 ..	50	
H (s) 10 ..	48 *	
B (s) 69 ..	46 *	
C (s) 15 ..	44 *	
H (s) 7 ..	41	
C (s) 457 ..	40 *	
C (s) 382 ..	39 *	
C (s) 35 ..	39	

* Samples for cooking tests were taken from these seedlings.

Y (s) 5 and H (s) 7, although giving good weights in the trials were eliminated on general appearance.

A COOKING TEST.

Five disinterested persons tasted each sample and gave independent judgments. As a result the following classification was made:—

I.	C (s) 15	Excellent.
Ia.	C (s) 372	Very good.
II.	C (s) 94	Good.
	H (s) 10	„
	C (s) 141	„
	C (s) 35	„
III.	C (s) 457	Fairly good.
	C (s) 128	„ „
	C (s) 305	„ „
	C (s) 323	„ „
IIIa.	A (s) 15	Fair.
	B (s) 69	„
IV.	C (s) 382	Poor.

C (s) 382 was eliminated on a yield and cooking quality basis, while A (s) 15 was eliminated on cooking quality and indifferent appearance of potatoes.

Eleven seedlings were thus left, viz. C (s) 305, C (s) 128, C (s) 94, C (s) 372, C (s) 141, H (s) 10, B (s) 69, C (s) 15, C (s) 457, C (s) 323, C (s) 35. These will be tried in the sweet potato variety catch crop trial of 1931.

(ii) SEEDLING POTATO LONG CROP TRIAL.

This trial comprised 132 seedlings, which were saved from complete caterpillar destruction at Applewhaites in the 1929-30 trial. These were planted at Guinea each in single plots of 16 cane holes (approximately 1/110 acre)—one hill to the cane hole. (One hill alone per cane hole was planted to admit of ascertaining the growth habits of each). Ten similarly sized plots of Red Nut were scattered throughout the experimental area to serve as a "check." Planting was done on the 18th of November, 1930 and digging on the 4th May, 1931—in all a growing period of 24 weeks.

The procedure at digging was as follows. At first all Red Nut plots were dug and weighed and their mean weight ascertained. The seedlings were then dug and at digging the mode, depth of bearing and weight of potatoes noted. Forty were selected on the appearance, mode and depth of bearing and weight of potatoes.

These are listed below:—

C (s) 342	C (s) 170	C (s) 141	G (s) 9
C (s) 307	C (s) 252	C (s) 128	G (s) 8
C (s) 257	C (s) 7	A (s) 45	H (s) 1
C (s) 364	C (s) 280	A (s) 15	H (s) 7
C (s) 31	C (s) 382	A (s) 44	H (s) 10
C (s) 219	C (s) 457	B (s) 24	M (s) 100
C (s) 68	C (s) 323	B (s) 294	Y (s) 3
C (s) 17	C (s) 94	B (s) 79	Y (s) 7
C (s) 366	C (s) 48	B (s) 177	Y (s) 13
C (s) 287	C (s) 99	B (s) 69	Y (s) 26

A cooking sample was obtained from each, cooked and tasted two to three days after digging. As a result of this test the following thirteen seedlings were eliminated:—

Y (s) 3	C (s) 170	H (s) 1	C (s) 252
Y (s) 7	M (s) 100	C (s) 99	C (s) 307
A (s) 15	B (s) 69	C (s) 31	C (s) 280
			C (s) 48

Samples of the twenty-seven seedlings retained, were put up in storage crates for observation on storage and for multiplication.

SECTION III.—COTTON.

SPACING EXPERIMENT.

Two spacings were employed, viz. (1) single rows at five feet apart, i.e., a single row to every cane hole row, and (2) a double row to every cane hole row. In the rows of both spacings two plants were allowed to grow at each of twenty inch intervals. Thus in a 5′ x 5′ lining, in the single spacing there were six plants to the cane hole, while in the double there were twelve plants.

There were twenty-three plots of each spacing and each plot occupied an area of one hundred cane holes (approximately 1/17 acre). The twenty-three comparable plot pairs were laid down on Student's system.

In each plot only the centre rows were picked so as to avoid a border effect of contiguous differently spaced plots. Thus there was, for picking, in each plot an area of sixty cane holes, and since, for any spacing there were twenty-three plots in all, each spacing was picked, for purposes of assessing its effect on yield, over approximately 8/10 of an acre.

Picking commenced on 19th January and ceased on 9th March. Picking was done at intervals of three to six days, depending on the amount of cotton ready for picking. In order to consider the effect of spacing on time of yield the picking season was divided arbitrarily into three periods, viz.

(1) 19th January—5th February.
(2) 9th February—23rd February.
(3) 25th February—9th March.

The results are presented in detail in the following table:—

COTTON—*Effect of Spacing on (a) Yield and (b) Time of Yield of Seed Cotton.*

"Comparable" Plots.

Yield of Seed Cotton in Pounds.

	SINGLE SPACING Total yield of 23 plots				DOUBLE SPACING. Total yield of 23 plots by periods.				Difference in favour of double over single spaced plots
	1st	2nd	3rd		1st	2nd	3rd		
Total	306·2	393·8	193·7	893·7	418·5	395·9	186 0	1000·4	+ 106·7
Per acre	387	497	244	1128	528	502	232	1262	+ 134·0
% Total	34·2	44·1	21·7	100·0	41·8	39·5	18·7	100·0	-
Mean yield	13·31	17·13	8·42	38·86	18·20	17·21	8·10	43·51	+ 4·65

The mean difference per plot in favour of double spaced plots over single is equal to 4.65 ± 1.46 pounds seed cotton. This difference is statistically highly significant ($t=3.187$: $p > .01$). This means a calculated increase in this experiment of approximately 134 pounds seed cotton per acre or approximately a 12% increase over the single spacing.

In this large scale experiment, not only did the double spacing increase the yield over single spacing, but it gave a greater proportion of its total pickings in the first two periods than the single spacing.

The importance of a high yield in a short time is apparent when the danger of pink boll worm and picking costs are considered, and this condition was obtained by the closer spacing.

Further it is of interest to note the high yield of seed cotton, viz. 1,200 pounds per acre, in the new planting season.

Chapter III.

AGRICULTURAL CHEMISTRY AND GOVERNMENT LABORATORY.

REPORT OF THE AGRICULTURAL CHEMIST.

(S. J. SAINT, B.Sc., A.I.C.).

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INTRODUCTION.

During the year under review a continuation has been made of the investigational work in sugar technology and local soils, as far as the routine official analytical work of the laboratory permitted.

Mr. C. A. Coppin continued his investigations of the quick vinegar process as applied to cane juice and achieved very satisfactory results. Mr. Coppin was away on leave from November, 1930 until April, 1931 and during his stay in Canada visited and inspected a malt vinegar plant. An account of his results and experiences is given in Section I.

Mr. T. A. E. Barker is carrying out an investigation into the various factors affecting the viscosity of molasses with a view to obtaining a better understanding of the crystallisation of massecuites. A summary of the work is included in the Sugar Technology Section.

SECTION I.—SUGAR TECHNOLOGY.

1. THE CRYSTALLISATION OF LOW PURITY MASSECUITES.

A paper (1) containing an account of the experimental work carried out to date with suggestions for future work has been published. It was intended to continue these investigations at Carrington Factory during the past crop season and a small crystalliser was made by the Barbados Foundry. This crystalliser is equipped with coils which serve the double purpose of circulating the massecuite and allowing the temperature of the massecuite to be regulated. It was not found possible to carry out any investigational work with this crystalliser owing to pressure of official analytical work and the number of advisory visits which were made.

2. THE VISCOSITY OF CANE SUGAR MOLASSES.

(T. A. E. BARKER, B.Sc.).

The speed of crystallisation of cane sugar from the mother liquor depends among other factors on the supersaturation and on the viscosity of the mother liquor. The supersaturation and the viscosity increases as the temperature decreases, one of these factors tending to speed up the crystallisation, and the other to retard it. With a view to finding an optimum temperature for the crystallisation process, the variation of viscosity with temperature was investigated.

For this purpose it was necessary to arrange an apparatus for determining the viscosity of thick liquids which would give constant results and lend itself to a temperature control.

The first method adopted was to fill a tall cylinder with the molasses, and to fix bands of silk thread round the outside spaced at equal distances, (every 5 cm.) down the jar. Steel ball bearings were then dropped in, the object being to note the time at which they passed each thread. Unfortunately the balls could not be seen owing to the opacity of the molasses, even when an electric arc was placed behind the cylinder. The only way to render them visible was to drop them down the side of the jar. In spite of this, no reliable uniform velocity could be obtained as the motion of the balls was too irregular. A final experiment was made with a large glass marble, which if carefully dropped down the side and viewed with an electric arc lamp could just be seen. A uniform velocity was obtained in this case, though no importance can be attached to the coefficient of viscosity found by this means, as the marble was probably rolling down the side of the jar. The results are given in the following table.

TABLE.

Mean Velocity of Ball.	Density of Ball.	Density of Molasses.	Viscosity at 28°C.	Radius of Ball
Cm. sec.	gm. per cc.	gm. per cc.	C.G.S. units.	cm.
1.18	2.48	1.42	224.63	1.071

Capillary Tube Method.

The next method tried was the capillary tube method. In this method, owing to the high viscosity of the molasses, a wide bore capillary 26cm. long was used in the apparatus shown in the diagram. The hydrostatic pressure of the molasses was augmented by an air pressure on the surface.

It will be seen from the following table that the results obtained with a vertical capillary, and a varying head of molasses are not reliable.

TABLE.

Expt.	Log. r^4	Pressure of Mercury	Mean level of Molasses	Weight of Molasses	Time of Outflow	Viscosity at 28°C.
		cm.	cm.	gm.	secs.	C.G.S. Units
1	$\bar{4}.24318$	37.4	4.8	33.99	900	34.36
2	$\bar{4}.24318$	33.4	4.2	28.98	1080	68.23
3	$\bar{4}.24318$	7.4	3.8	18.41	1800	51.48

The apparatus used in these experiments is featured in Fig 1. of plate 8.

Horizontal Capillary Tube Method.

The previous experiment was repeated with a modified form of apparatus employing a horizontal capillary tube with a temperature control. The difficulties attendant upon a variable head of molasses were overcome by arranging to supply molasses to the container at the same rate as the molasses escaped from the capillary tube. If the apparatus is airtight, any change in the level of the molasses will reveal itself on the air pressure gauge, and the supply of molasses has to be regulated so as to keep this pressure constant. The apparatus used is shown in Fig. 2. of plate 8. For a number of different temperatures, the experiment was performed under three or four different pressures, and the close agreement between results obtained at the same temperature but with different pressures, fills one with a certain amount of satisfaction that the method adopted is a suitable one. Some difficulty was experienced in keeping the temperature constant during the experiments. With a little practice however, the temperature was maintained between 0.5°C. above and 0.5°C. below the temperature specified in the results, and the small differences in the results at any one temperature may be attributed to this small variation in temperature.

At higher temperatures, i.e. above 60°C., greater difficulty was experienced in keeping the temperature constant, and here the actual temperature varied between 1°C. above and below the temperature specified. However, these variations at the higher temperatures are not so important as at lower temperatures, since above 60°C., a large change in temperature produces but a small change in viscosity. Another difficulty met with at higher temperatures was the formation of a surface skin round the drops of molasses.

The whole experiment was then repeated with a different concentration of molasses. The idea was to use about seven different concentrations, and

PLATE 8

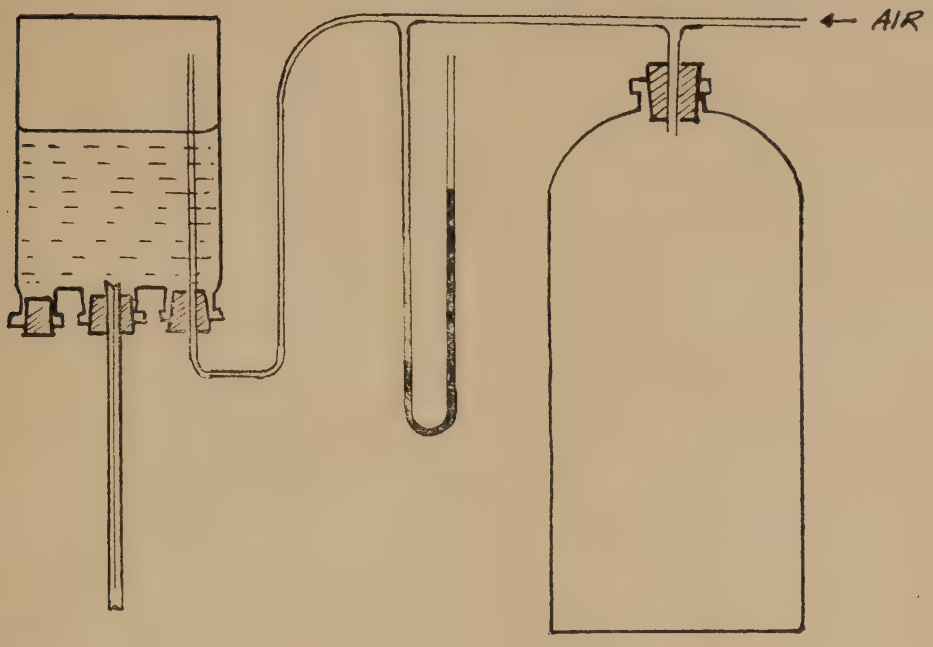


FIG 1

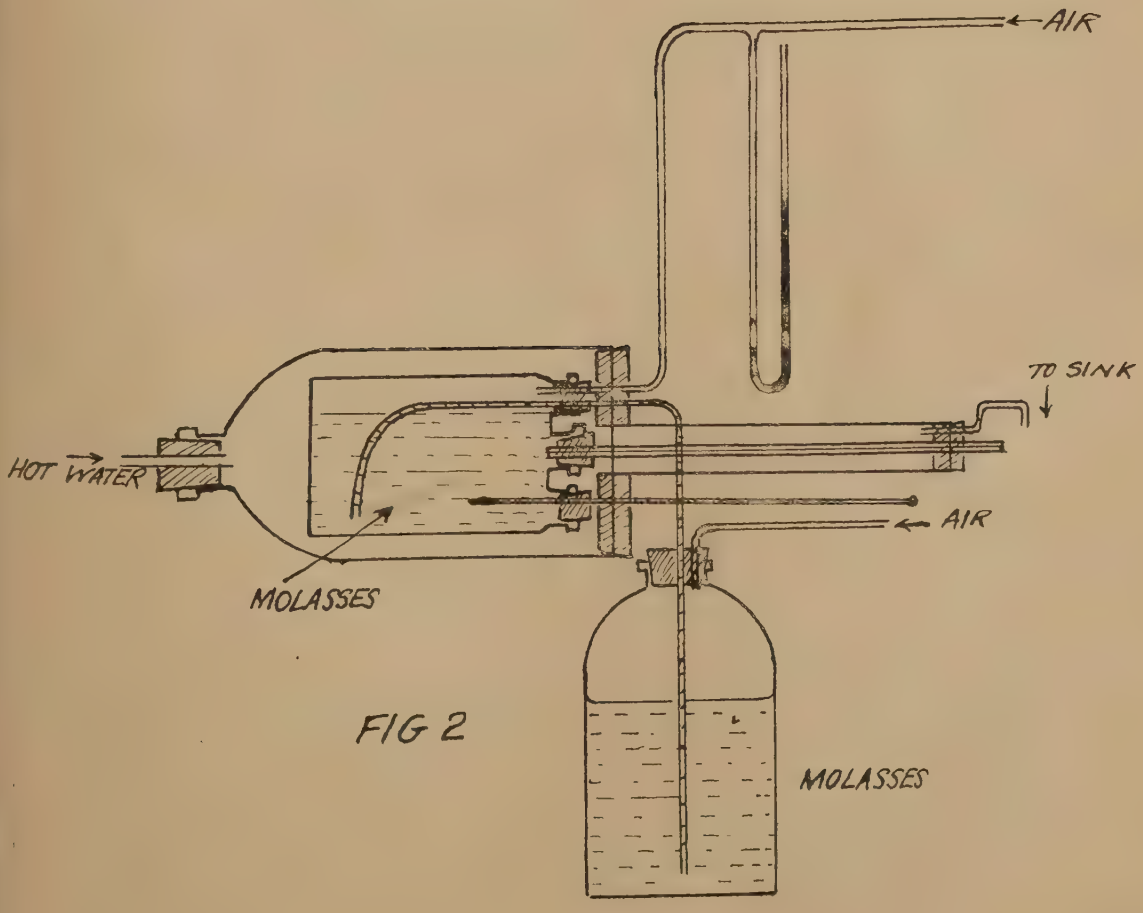
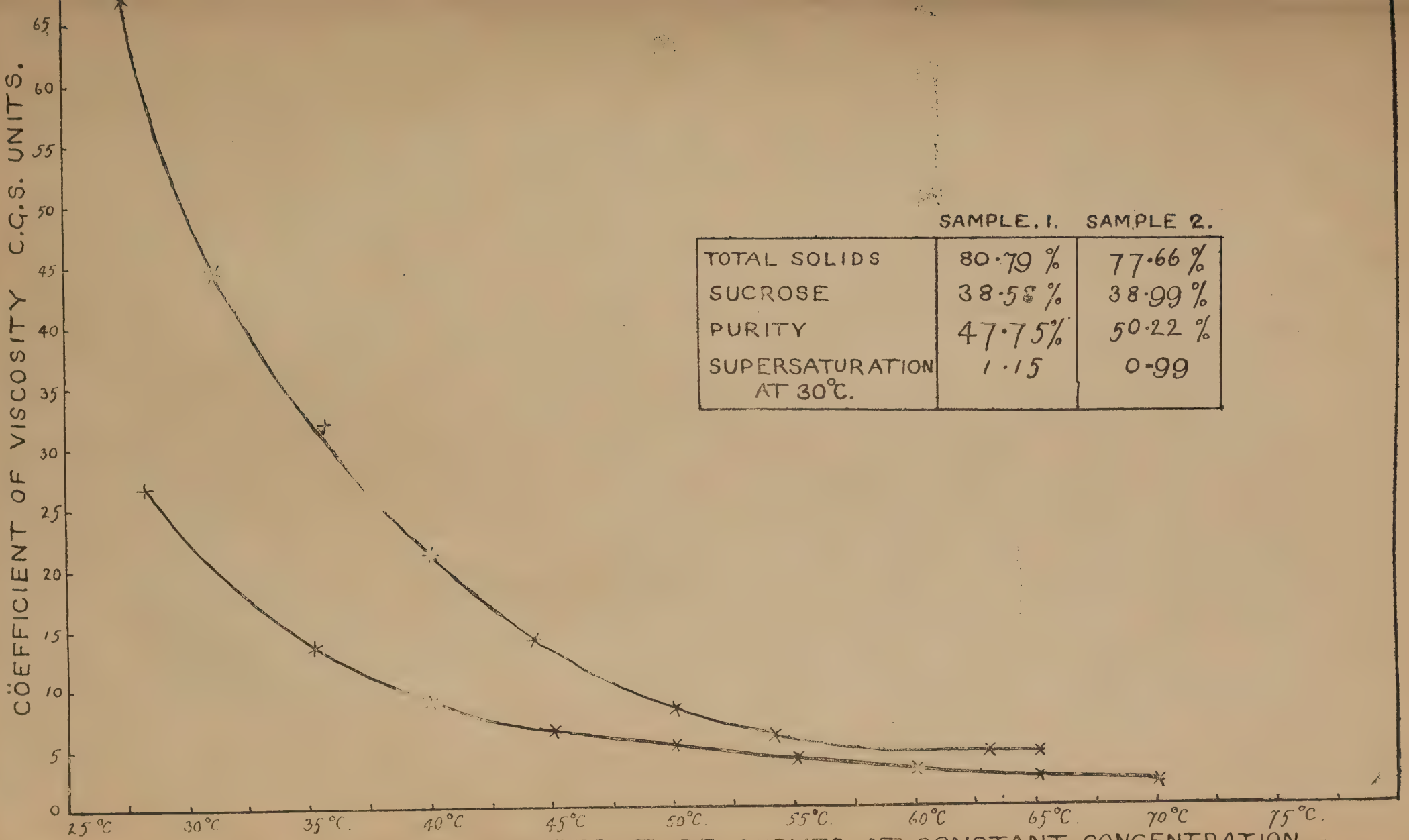


FIG 2



	SAMPLE. 1.	SAMPLE 2.
TOTAL SOLIDS	80·79 %	77·66 %
SUCROSE	38·58 %	38·99 %
PURITY	47·75%	50·22 %
SUPERSATURATION AT 30°C.	1·15	0·99

Fig.3 . VISCOSITY – TEMPERATURE CURVES AT CONSTANT CONCENTRATION.

from these curves to construct curves at constant supersaturation. Time however did not permit more than two solutions to be used. The amount of sucrose or water to be added to give the desired concentration was calculated and the actual data determined afterwards by an analysis of the sample.

In spite of the incompleteness of the results, both samples show the viscosity to change rapidly up to 50° to 55°C., whilst above that the change is slow, becoming practically constant at 65°C. Thus, assuming that a low viscosity favours a rapid crystal growth the optimum curing temperature (as far as viscosity is concerned) is above 50°C.

The data obtained for the two molasses containing 77.66% total solids and 80.79% total solids respectively are set out in the following tables (A and B). The relationship between the coefficient of viscosity and the temperature is shown in Plate 9.

TABLE A.

VARIATION OF VISCOSITY AT CONSTANT CONCENTRATION.

Sample I. Total Solids=80.79%.

Temp.° C.		27·4	31	35·5	40	44	50	54	63	65
Viscosity determinations C.G.S. Units	1	67·015	43·940	32·919	21·625	14·958	8·086	5·538	4·147	3·942
	2	66·511	44·635	32·063	21·082	14·182	8·437	5·587	4·539	3·510
	3	68·049	45.353	32·982	20·801	14·522	7 818	4·710	5·011	4·847
	4	65·711	44.043	...	...	14·814	. .	...	...	...
Mean Viscosity		66·82	44·50	32·65	21·17	14·62	8·11	5·55	4·57	4·123

TABLE B.

Sample II. Total Solids =77.66%.

Temp.° C.		28·5	35	40	45	50	55	60	65	70
Viscosity determinations C.G.S. Units	1	25·79	12·60	7·64	5·09	4·81	3·44	2:407	2·022	1·63
	2	26·04	15·64	8·36	6·25	4·33	3·72	2·539	1·911	...
	3	26·43	14·41	8·41	6·83	5·045	3·01	2.734	2·320	...
	4	27·80	13·25	8·59	7·02	5·42	3·81	2·495	2·585	...
Mean Viscosity		26·51	13·98	8·25	6·29	4·9	3·51	2·54	2·21	1·63

3. SYRUP MANUFACTURE.

A number of advisory visits were made during the crop season to syrup factories where difficulty was being experienced with a fermentation after the molasses had been discharged into coolers. This trouble was new to many experienced syrup manufacturers and the frequent occurrence during this crop season would appear due to some abnormal properties of the juice owing to the dry growing season of 1930.

The fermentation was obviously allied to the froth fermentation which sometimes takes place in low purity massecuites which have been boiled at too high a temperature. The syrup would be perfectly normal on leaving the Aspinal pan and if the sample cooled quickly, it retained its colour and flavour. The same molasses discharged into a tank would remain at a temperature of 180—190°F. for as much as twenty-four hours. During this time the molasses turned red and a dirty white froth appeared on the surface; eventually, caramelisation took place with the result that the syrup darkened and acquired a burnt flavour. The froth fermentation of massecuites is considered to be due to reactions between amino-acids and invert sugar resulting in the evolution of carbon dioxide. Such reactions only take place at a high temperature. It was found that the fermentation of fancy molasses could be prevented by cooling the syrup rapidly as it left the Aspinal pan to a temperature of about 160°F. The syrup could then be safely run into tanks to cool without the

slightest risk of fermentation. The initial cooling can be carried out by allowing the syrup during its passage from the pans to the tanks to run along a shallow trough or fall over a cooling tower or pass through a juice heater through which cooling water can be circulated.

4. THE MANUFACTURE OF VINEGAR FROM CANE JUICE.

(C. A. COPPIN, B.A. Sc.) .

In an article published in this Report last year (Report Dept. Sc. & Ag. 1929-1930) some details of an investigation into the manufacture of vinegar from cane juice by a quick vinegar process were given. The conditions under which a rapid fermentation of the juice by a pure culture yeast could be obtained were worked out, and experiments were set in progress dealing with the second stage of acetification of the fermented juice.

Here the two chief requisites are—a selected culture of acetic bacteria, and means whereby the oxidation of alcohol to acetic acid can be as rapid as possible.

The culture was selected from cane juice that had been allowed to go acid spontaneously and was grown in the culture medium recommended by Janke* (Vinegar Manufacture—Mitchell, p.200). To avoid subsequent contamination from air—and yet to propagate the culture—use was made of the Laboratory glass generators recommended by Bureau of Chemistry, U.S. Dept. of Agriculture (Ind. & Eng. Chem. Vol. I p. 260). In the absence of beech shavings, generators were filled with oak shavings which had previously been twice boiled in water to remove any pine oils, etc. A sterile cane juice was used to which the above selected bacteria were added. Filtered air only was admitted to these generators.

Acetification proceeded slowly and at the end of about 4 weeks a quantity of "mother of vinegar" had developed in the generator. This "mother of vinegar" was subsequently used in the acetifiers.

A wooden experimental generator or acetifier was built after the type of those used in the quick vinegar process. The acetifier functions by permitting the alcoholic liquor to be exposed in thin films to the action of the Bacteria and the oxygen of the air. The type used was about 20 inches square in section and 5 feet high. About 1/6 of the way up from the bottom a perforated false bottom was fixed and the space above this was loosely packed with a suitable type of filling upon which the bacteria can develop and air can freely circulate. This air was admitted through a number of holes bored in the sides of the box below the false bottom. The apertures of these holes could be regulated.

The fermented juice or the alcoholic liquor was run in at a regulated rate to a small distributor box packed with cotton wicks; it was then distributed by means of these wicks over the filling material down which it slowly trickled in thin films. The activity of the bacteria with which the filling material was inoculated causes the temperature to rise several degrees and thus a current of warm air ascends, escaping through the pieces of glass tubing passing through holes in the top of the apparatus; at the same time fresh air is drawn in through the holes below the false bottom. Thus a constant circulation of air is automatically maintained by the working of the acetifier and the thin films of fermented liquor are thus exposed continuously to the air.

A general view of the acetifier can be seen in Plate X.

The type of filler for the acetifier may be selected from a wide range of materials. Thus megass, charcoal, wicker work, shavings, crushed cane stems were tried out with more or less success. The type selected for these experiments consisted of "deal shavings" which had been first boiled in water and then spread on thin shallow perforated deal trays or trays of basket wicker. No metal of any kind was used in the construction of the acetifier or trays for the filling material. It must be borne in mind that the type of filler must be

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Potassium diphosphate	9.4	grams.	dissolve in one litre of water and add 40 cc. of 95% alcohol.
Ammonia diphosphate	1.0	„	
Magnesium sulphate	0.4	„	
Succinic acid	1.0	„	
Glycerine	5	cc.	

PLATE X.

innocuous to the bacteria, must be unaffected by alcohol and acetic acid, and when packed must permit free circulation of air. Undoubtedly beech shavings are ideal in this respect, but owing to the difficulty of procuring beech in Barbados, resort had to be made to deal after treatment as above.

The operation of the above acetifier was started as follows: the filling was first inoculated with selected culture and then a small portion of fermented liquor was run in through the distributor box. After passing through the acetifier it slowly flowed away from the box where it was collected and poured back through the distributor three or four times. At the end of about 24—26 hours the temperature inside the acetifier had risen to about 95°F. and it was ready for continuous operation. Fermented liquor, from which most of the yeast has settled out, or otherwise removed, is fed continuously to the distributor. A clear vinegar flows away from the base and may be fed back to the distributor if a strong vinegar is required. After several weeks operation the efficiency of the generator may fall off through clogging of the filler with "mother of vinegar." The type of acetifier was so constructed that the frame could be easily removed and the trays cleaned and replaced. Plate X shows generator with frame removed. The nature and arrangement of the filling material, wicks, false bottom, central vapour tube, etc., can be seen from this photograph.

For efficient operation of the above type of acetifier, the temperature inside must be controlled, and this is done by regulating the air supply by closing or opening the air holes at the base. It may also be controlled to some extent by the rate at which liquor is supplied through the distributor. The optimum temperature is 95°F. and it is important that the temperature be maintained around this figure. Temperatures exceeding 100°F. are easily attained, and whilst such temperature speeds up the process, loss of alcohol is great both on account of evaporation loss and loss through over-oxidation to carbon dioxide. When operated efficiently the conversion of alcohol to acetic acid should be between 90–95 per cent. of the theoretical. Efficiency below this means excessive air supply.

The vinegar obtained after being put through the acetifier three or four times usually contains about 5–6 per cent. acetic acid, depending upon the original alcoholic content. By adding further supplies of alcohol, acetic acid contents up to 10 per cent. can be obtained.

The addition of small quantities of Nutrients (Nitrogen, Potash, Phosphate) did not appreciably affect the rate of acetification. From the analysis figures it is apparent that the cane juices themselves carry a sufficiency of nutrients for the bacteria, and some nutrients are usually left over for the alcohol fermentation stage.

It may be noted that whilst cane juices were used in the majority of these experiments, equally satisfactory results have been obtained by using sugar solutions made from syrups, fancy molasses, etc. A solution of about 15°Brix is made, fermented with yeast and subsequently acetified. They yield clear bright vinegars of excellent flavour, and with good keeping properties, quite suitable for domestic table use.

The opportunity presented by a vacation in Canada gave the writer a chance of continuing a further study of practical vinegar production on a large scale. In the light of the experience gained on the construction and actual operation of commercial generators, it became apparent, that whilst the principle and methods of operation detailed above are fundamentally sound, the actual construction of the acetifier can be modified with advantage. The chief features to which attention must be drawn are:

(1) Simplicity of construction: The type of generator universally used is almost cylindrical in shape, being slightly wider at the base than at top. It can be made from wood plank by an experienced cooper. The type employed in the above description is square, and was so made in order that it may be easily cleaned. The cylindrical type, however, is cheaper to construct, and can be made water-tight far easier, thus obviating the use of paraffin wax,etc. to prevent leaks. It further permits a more uniform distribution of liquor and air and prevents stagnation with consequent contamination which is most likely to occur in corners.

(2) The type of filling is an important consideration, regulating as it does the life of the generator and the frequency of renewal through clogging. Operating experience suggests the advisability of retaining

beech shavings as the most successful type of filler. It is primarily the shape and curl of these shavings that make them a most serviceable type of filler.

(3) The distribution of the liquor by means of a revolving sparge, operated by the gravity and outflow of the liquor is preferable to the method of wick distribution. The sparge, which resembles a rotating garden water spray—is of simple construction and functions well without attention to clogging, etc.

(4) One of the most salient features of quick vinegar production which must be particularly noted, is with regard to the size of generator employed. The larger the size of the generator, the more smoothly and efficiently they run. Small generators have low efficiencies, and in the absence of experienced and rigid attention can easily get out of control. They readily clog and are very susceptible to contamination of all sorts. It is therefore inadvisable to consider the production of vinegar commercially in small units, but rather in as large a unit as possible. Generators of 7–10 ft. in diameter and 12–15 ft. high, capable of producing 6,000–10,000 gallons of vinegar monthly are in common use; these function with around 95% efficiency, and require minimum attention. Packed with beech shavings they can run for 2½ years without renewal of packing.

SECTION II.—MANURIAL TRIALS.

The growing season of 1930-31 was an exceptionally dry one and, since the rainfall is normally the main factor limiting plant growth under Barbados conditions, the differential effects of manuring have had less than the average chance of affecting yield during the year under review. This point must be borne in mind in the discussions which follow.

1. SUGAR CANE.

(*a*) TYPE I.

The Type I. trial which was fully described in last year's report (2) was continued and the ratooned cane was manured at both black and red soil centres. All of the plots were treated similarly and the manuring was based on general estate practice. An application at the rate of 22 lb. nitrogen and 112 lb. potash (K_2O) per acre was given soon after the plant canes were reaped. This was followed by an application at the rate of 45 lb. nitrogen per acre in July. The nitrogen was given in the form of sulphate of ammonia and the potash as sulphate of potash.

It was expected that any residual effects of the various manures applied to the plots in the previous growing season would affect the yield of the ratoons.

The particulars as regards treatment, yield, etc. for plant canes (1929-30) and ratoons (1930-31) are set out in the following tables (A and B) and any further details regarding this experiment will be found in last year's Report.

TABLE A.

Plot.	Treatment (per acre.)		Mean yield. (per acre.)		Difference from Plot 1.	
	Plant Canes.	Ratoons.	Plant Canes.	Ratoons.	Plant Canes.	Ratoons
1	Unmanured	3 cwt. N. + 2 cwt. K.	22·4	14·5	0	0
2	4 sqs. Pen Manure ...	as 1	27·1	16·1	4·7	1·6
3	2 sqs. Pen Manure ... + 4½ cwt. N. ... ... + 1 cwt. P. ... ... + 1¾ cwt. K.	as 1	29·7	16·9	7·3	2·4
4	Trash + 3½ cwt. N. ... + 3 cwt. P. + 3 cwt. K. ...	as 1	30·6	16·2	8 2	1·7
5	3½ tons Sheep Manure ...	as 1	26·0	16·8	3·6	2·3
6	1½ cwt. C.S.M. ... .. + 1 cwt. K.	as 1	29·3	14·2	6·9	0·3
7	¾ ton Fish Manure ...	as 1	25·8	16·9	3·4	2·4
8	3½ cwt. N. + 3 cwt. P.... + 3 cwt. K.	as 1	27·1	14·7	4·7	0·2
9	9 cwt. N. + 2 cwt. P. ... + 3½ cwt. K.	as 1	29·4	15·4	7·0	0 9

TABLE B.

Plot	Treatment (per acre.)		Mean yield per acre.		Difference from Plot 1.	
	Plant Canes.	Ratoons.	Plant Canes	Ratoons	Plant Canes.	Ratoons
1	Unmanured	3 cwt. N. + 2 cwt. K.	26·7	32·0	0	0
2	4 sqs. Pen Manure ...	as 1	38·5	32·9	11·8	0·9
3	2 sqs. Pen Manure ... + 4½ cwt. N. + 1 cwt. P ... + 1¾ cwt. K.	as 1	39·1	31·8	12·4	0·2
4	Trash + 3½ cwt. N. ... + 3 cwt. P. + 3 cwt. K ...	as 1	40.0	30·2	13 3	1·8
5	3½ tons Sheep Manure ...	as 1	33·4	32·4	6·7	0·4
6	1½ cwt. C.S.M. ... ... + 1 cwt. K.	as 1	35·4	33·4	8·7	1·4
7	¾ cwt. Fish Manure ...	as 1	35·3	31·9	9·1	0·1
8	3½ cwt. N. + 3 cwt. P ... + 3 cwt. K.	as 1	36·4	32·2	9·4	0·2
9	9 cwt. N. + 2 cwt. P. ... + 3½ cwt. K.	as 1	39·6	31·1	12·9	2·1

NOTES ON TABLES.

(1) *Under Treatment* N = Sulphate of ammonia.
P = Superphosphate.
K = Sulphate of Potash.
C.S.M. = Cotton Seed Meal.

(2) *Statistical Analysis.*
Differences in yield which have a 20:1 chance of being due to differences in manurial treatment should be greater than:—

(a) *For Black Soil Centres.*
4.7 tons per acre for plant canes and 2.5 tons per acre for ratoons.

(b) *For Red Soil Centres.*
3.1 tons per acre for plant canes and 3.2 tons per acre for ratoons.

CONCLUSIONS.

In view of the fact that all the ratooned cane on these plots received the same manuring, it is almost certain that a significantly increased yield of any plot over Plot 1 will be due to the residual value of the manures to the plant canes.

At the black soil centre the increased yields of Plot 3, Plot 5 and Plot 7 over Plot 1 can be regarded as just significant. The plant cane growing on these plots received pen manure plus artificials,—sheep manure and fish manure respectively. As would be expected, the mixtures of sulphate of ammonia, superphosphate and sulphate of potash applied in the first year to plots 4, 8 and 9 have had no effect on the yield of the ratoons. It is surprising to note that the heavy dressing of pen manure applied to the plant cane on Plot 2 has given no significantly increased yield to the ratoons. Cotton seed meal is recognised as quite a quick acting nitrogenous manure on local soils and the results of these experiments verify this observation since it appears that this manure is exhausted by the first crop.

At the red soil centre, it is evident that no manure applied to the plant cane has had any significant effect on the yield of the ratoons. These results are noteworthy when taken in conjunction with the relatively small residual values noted for certain manures on the black soils. It is evident that organic manures are very much more active on these calcareous tropical soils than they are in more temperate climates.

In the following table has been set out the total increased yields for the plant canes and ratoons of the various plots over Plot I. together with the mean increased yield for both centres. The actual profit and loss of the various increased yields when compared with the cost of the manure producing these increased yields with cane at $3.50 per ton is also given.

TABLE.

Plot.	Total Increased Yield over Plot 1.			Value of increase @ $3·50 per ton.	Cost of Manuring per acre over Plot 1.	Difference Profit or Loss per acre.
	Black Soil Centre tons.	Red Soil Centre tons.	Mean of Red and Black tons.	$	$	$
1	0	0	0	0	0	0
2	6·3	12·7	9·5	33·3	44·8	−11·5
3	9·7	12·2	11·0	38·5	45·0	− 6·5
4	9·9	11.5	10·7	37·5	28·0	+ 9·5
5	5·9	7·1	6·5	22·8	45·5	−22·7
6	6.6	10·1	8·4	29·4	45·3	−15·9
7	5·8	9·0	7·4	25·9	45·0	−19·1
8	4·9	9·6	7·3	25·5	24·0	+ 1·5
9	7·9	15·0	11·5	40·2	45·2	− 5·0

The results of such a balance sheet are very striking and fully confirm the conclusion put forward in last year's report.

It is evident that the practice of mulching with trash or similar material together with a dressing of artificials supplying the necessary nitrogen and potash is the only economical method of manuring at present prices of cane. Reference to Tables A and B shows that sheep manure, fish manure, cotton seed meal, although giving increased yields of cane, give those increased yields at a loss when the value of the increase is compared with the cost of the manure.

(*b*) TYPE II.

This trial was described fully in last year's report. It was continued at the red soil centre with the ratoons; the cane at the black soil centre was not ratooned so that the results of only one centre can be reported on.

All of the plots were treated similarly and received an application of 22 lb. nitrogen and 112 lb. potash per acre, soon after the plant canes were reaped; this was followed by an application of 45 lb. nitrogen per acre in July. The nitrogen was supplied as sulphate of ammonia and the potash as sulphate of potash.

The treatments, yield, etc. for the plant cane (1929–30) and ratoons (1930–31) are set out in the table below. Any further details of this trial can be found on reference to last year's Report.

Plot.	Treatment (per acre).					Mean acre Yield per Plant Canes (tons).	Ratoons.	Difference from	
	Plant Canes.			Ratoons.				Plot Plant Canes.	12 (tons) Ratoons.
	N. lb.	P_2O_5 lb.	K_2O lb.	N. lb.	K_2O lb.				
1	67	60	112	67	112	28·5	31·3	+8·6	+4·4
2	67	60	–	67	112	19·0	26·0	−0·9	−0·9
3	67	–	112	67	112	25·6	29·7	+5·7	+2·8
4	–	60	112	67	112	26·3	31·8	+6·4	+4·9
5	67	–	–	67	112	18·8	29·1	−1·1	+2·2
6	–	–	112	67	112	24·0	28·9	+4·1	+2·0
7	–	60	–	67	112	17·2	24·6	−2·7	−2·3
8	89	60	112	67	112	28·1	33·9	+8·2	+7·0
9	112	60	112	67	112	26·0	32·1	+6·1	+5·2
10	67	60	168	67	112	26·4	32·1	+6·5	+5·2
11	67	60	224	67	112	29·1	31·2	+9·2	+4·3
12	–	–	–	67	112	19·9	26·9	0	0

Notes on table.

(1) N = Nitrogen as sulphate of ammonia.
P_2O_5 = Phosphoric acid as superphosphate.
K_2O = Potash as sulphate of potash.

(2) The statistical analysis shows that any difference in the mean yield of the plots greater than 4.3 tons for the plant cane and 5.2 tons for the ratoons has a 20:1 chance of being due to differences in manurial treatment.

In order to consider the possible effects on the yield of the ratoons of the various combinations of nitrogen, prosphoric acid and potash applied to the plant cane, the effects of each constituent will be considered separately.

(1) THE EFFECTS OF NITROGEN ON THE YIELD.

TABLE.

Plot.	Treatment of plant cane (per acre.)			Plant cane (per acre.)		Ratoons (per acre.)	
	lb. N.	lb P_2O_5	lb. K_2O.	Difference over unmanured (tons.)	Difference between means of six plots (tons.)	Difference over unmanured (tons.)	Difference between means of six plots (tons.)
12	–	–	–	0·0		0·0	
					–1·1		+2·2
5	67	–	–	–1·1		+2·2	
7	–	60	–	–2·7		–2·3	
					+1·8		+1·4
2	67	60	–	–0·9		–0·9	
6	–	–	112	+4·1		+2·0	
					+1·6		+0·8
3	67	–	112	+5·7		+2·8	
4	–	60	112	+6·4		+4·9	
					+2·2		–0·5
1	67	60	112	+8·6		+4·4	
Differences between means of 21 plots					+1·1		+1·0

NOTES.

A difference in yield between means of 24 plots has a 20:1 chance of being significant if greater than 1.7 tons per acre for plant canes or 2.6 tons per acre for ratoons.

The addition of 67 lb. of nitrogen as sulphate of ammonia to the plant cane gave an average increased yield of one ton of cane per acre for both plant cane and ratoons, but this increased yield cannot be regarded as significant.

(2) THE EFFECTS OF POTASH ON THE YIELD.

In the next table the effect on the yield of plant canes and ratoons of an addition of 112 lb. potash per acre applied in the first year is shown. The cane growing on this experimental field has shown a marked response to this application of potash. Not only is there a mean difference of 7.4 tons per acre between the plant canes receiving potash and those not receiving potash, but the application of potash to the plant cane has resulted in a further increase in the mean yield of the ratoons of 3.8 tons per acre, notwithstanding the fact that all the plots received potash at the rate of 112 lb. K_2O per acre as ratoons.

The marked effect of potash on the yield of sugar cane growing on potash deficient soils in Barbados is noteworthy. Observations of cane growing in the field more especially in the red soil areas, lead one to suppose that ratooned cane may not uncommonly suffer from potash starvation. If the plant cane has not received a heavy application of pen manure, it is considered that the ratooned cane should receive 80–100 lb. K_2O per acre each year. If the available potash in the soil is kept above a certain limiting amount, further additions of potash have no effect on the yield, but if the available potash falls below this limiting amount, potash manuring is essential if the maximum yield of cane is to be obtained. This limiting amount of potash for the coral limestone soils seems to correspond approximately to an exchangeable potash figure of 0.014%. This figure was obtained last year as a result of a correlation study between the yields of manurial and variety trials with the corresponding soil analyses.

TABLE.

Plot.	Treatment of plant cane (per acre).			Plant cane (per acre.)		Ratoons (per acre.)	
	lb. N.	lb. P_2O_5	lb. K_2O.	Difference over unmanured (tons.)	Difference between means of six plots (tons.)	Difference over unmanured (tons.)	Difference between means of six plots. (tons.)
12	...	...	...	0·0		0·0	
					+4·1		+2·0
6	...	...	112	+4·1		+2·0	
7	...	60	...	−2·7		−2·3	
					+9·1		+7·2
4	...	60	112	+6·4		+4·9	
5	67	...	...	−1·1		+2·2	
					+6·8		+0·6
3	67	...	112	+5·7		+2·8	
2	67	60	...	−0·9		−0·9	
					+9·5		+5·3
1	67	60	112	+8·6		+4·4	
Differences between means of 24 plots					+7·4		+3·8

Notes.

A difference in yield between means of 24 plots has a 20:1 chance of being due to treatment if greater than 1.7 tons per acre for plant canes or 2.6 tons per acre for ratoons.

The addition of 67 lb. of nitrogen as sulphate of ammonia to the plant cane gave an average increased yield of one ton of cane per acre for both plant cane and ratoons, but this increased yield cannot be regarded as significant.

(3) THE EFFECT OF PHOSPHATE ON THE YIELD.

In the table below the effect on the yield of plant cane and ratoons of 60 lb. P_2O_5 per acre applied as superphosphate to the plant cane is shown.

Reference to this table shows that the mean difference between the yield of 24 plots gave an increased yield of 0.7 ton per acre to the plant cane and a decreased yield of 0.9 ton to the ratoons. Neither of these differences can be judged significant. It can therefore be safely concluded that the addition of 60 lb. of $_2O_5$ as superphosphate has had no effect on the yield of either plant cane or ratoons.

In all the phosphate experiments so far carried out on the coral limestone soils of Barbados there has been no significant increase in yield of sugar cane as a result of phosphatic manuring. The application of phosphate to these soils is therefore not recommended at present.

TABLE.

Plot	Treatment of plant cane (per acre)			Plant cane		Ratoons	
	lb N.	lb. P_2O_5	lb. K_2O	Difference over Unmanured (tons)	Difference between means of six plots (tons)	Difference over Unmanured (tons)	Difference between means of six plots (tons)
12	...	..	...	0·0		0·0	
					−2·7		−2·3
7	...	60	...	−2·7		−2·3	
6	...	...	112	+4·1		+2·0	
					+2·3		+2·9
4	...	60	112	+6·4		+4·9	
5	67	...	...	−1·1		+2·2	
					+0·2		−3·1
2	67	60	...	−0·9		−0·9	
3	67	...	112	+5·7		+2·8	
					+2·9		+1·6
1	67	60	112	+8·6		+4·4	
Differences between means of 24 plots					+0·7		−0·9

Notes.

A difference in yield between means of 24 plots has a 20:1 chance of being due to treatment if greater than 1.7 tons per acre for plant canes or 2.6 tons per acre for ratoons.

The addition of 67 lb. of nitrogen as sulphate of ammonia to the plant cane gave an average increased yield of one ton of cane per acre for both plant cane and ratoons, but this increased yield cannot be regarded as significant.

(*c*) TYPE III.

The manuring in this experiment was planned on the lines of general estate practice with the object of determining the effects on the yield of plant cane of different amounts of manure and of different times of application of similar quantities of nitrogen. Two squares or approximately sixteen tons of pen manure were applied to all plots just before the cane was planted. The time of application and amounts of the artificial manures applied to each plot are given below where particulars of yield are also given.

The experiment was put down at a red and black soil centre in the form of randomised blocks with six replicates of each treatment.

BLACK SOIL CENTRE.

Plot	Treatment per acre (In addition to 2 sqs Pen Manure.)			Time of appli'tion of Manures					Mean Yield per acre (Tons)
				January			July	Sept	
	N lb	P_2O_5 lb	K_2O lb	N lb	P_2O_5 lb	K_2O lb	N lb	N lb	
1	45	40	80	0	40	80	45	0	17.0
2	45	40	80	15	40	80	30	0	18.8
3	60	40	80	0	40	80	60	0	18.0
4	60	40	80	15	40	80	45	0	17.4
5	60	40	80	0	40	80	30	30	18.4
6	60	0	80	15	0	80	45	0	19.6
7	60	80	80	15	80	80	45	0	17.8
8	60	40	0	15	40	0	45	0	17.5
9	60	40	40	15	40	40	45	0	18.4
10	60	40	60	15	40	60	45	0	18.8

RED SOIL CENTRE.

Plot	Treatment per acre In addition to 2 sqs Pen Manure.)			Time of application of Manures					Mean Yield per acre (Tons)
				January			July	Sept	
	N lb	P_2O_5 lb	K_2O lb	N lbs	P_2O_5 lb.	K_2O lb.	N lb.	N lb	
1	70	40	80	0	40	80	70	0	43.5
2	70	40	80	15	40	80	55	0	40.6
3	85	40	80	0	40	80	85	0	41.4
4	85	40	80	15	40	80	70	0	41.5
5	85	40	80	0	40	80	55	30	42.6
6	70	0	80	15	0	80	55	0	40.9
7	70	80	80	15	80	80	55	0	41.7
8	70	40	0	15	40	0	55	0	39.9
9	70	40	40	15	40	40	55		41.0
10	70	40	60	15	40	60	55	0	40.9

Notes on Tables.

(1) Under Treatment. N = Nitrogen as sulphate of ammonia.
P_2O_5 = Phosphoric acid as superphosphate.
K_2O = Potash as sulphate of potash.

(2) *Statistical Analysis.*
Any difference in the mean yields greater than 2.3 tons per acre in the case of black soil centre and 5.2 tons per acre in the case of the red soil centre has a 20.1 chance of being due to differences in manurial treatment.

CONCLUSIONS.

In neither experiment can any of the differences in yield of cane between differently treated plots be regarded as significant.

The addition of 40 or 80 lb. phosphoric acid as superphosphate per acre to the two squares pen manure has had no significant effect on the yield at either station. It is also evident that the addition of 40, 60 or 80 lb. of potash as sulphate of potash per acre to the two squares pen manure has had no significant effect on the yield.

There was no "No nitrogen" plot so it cannot be said whether the addition of the initial dose of nitrogen as sulphate of ammonia has had any effect on the yield. It is evident, however, from this experiment that the yield of cane is not increased significantly if the application of nitrogen as sulphate of ammonia is increased by 15 lb. per acre when there has been a basal dressing of two squares of manure. There is also no significant effect on the yield if the nitrogen is applied partly in January and July or all in July or partly in July and September.

As this experiment was designed to test out a general plantation type of manuring, the centres chosen were representative of this general type of estate and the fields on which the trials were laid down were in "good heart." This fact must be borne in mind when considering these results. Under these conditions, however, it is evident that the yield of cane is limited by factors other than manure. When a basal dressing of two squares of pen manure is applied to such land it is extremely improbable that any addition of phosphoric acid or potash will yield economic returns in a normal year. Nor is it likely that nitrogen as sulphate of ammonia in excess of 45 lb. per acre will increase the yield under the conditions mentioned.

The mean yield of all plots at the red soil centre was 41.4 tons per acre, whilst at the black soil centre the mean yield was 18.2 tons per acre. It has already been shown that at neither centre is there any evidence to indicate that the yield was limited by lack of added fertilizer. A study of the rainfall during the fifteen months period over which the cane was in the fields shows that the red soil centre received 76.8 inches, whilst the black soil centre received 51.2 inches. Field observations during the growing season support the conclusion that the difference in rainfall is largely if not entirely responsible for a difference in yield of cane at the two centres.

This conclusion serves once again to emphasize the importance of water under Barbados conditions and why the conservation of soil moisture should be in the forefront of all agricultural operations.

II. SOUR GRASS.

(1) DEMONSTRATION PLOTS.

Demonstration plots to illustrate the effect of manurial applications to sour grass pastures were laid out on main road sites at five plantations. The experiment consisted of alternating strips of manured and unmanured grassland. The manure used was a mixture of two parts sulphate of ammonia, one part superphosphate and one part muriate of potash and was applied at the rate of 4 cwts. per acre. The manured plots showed up very well in the wetter districts, but the demonstration would have been even more successful with a normal rainfall.

(2) MANURIAL TRIALS.

The experiments carried out at a red and black soil centre and described in last year's report were continued. All of the plots were given a dressing of sulphate of ammonia at the rate of 2 cwt. per acre.

The results showing treatment, yield, etc., for the two years are set out below.

Plot	Treatment per acre.		Mean Yield of Grass (lb. per acre)			
	First Year.	Second Year.	Red Soil Centre.		Black Soil Centre.	
	1929.	1930.	1929.	1930.	1929.	1930.
1	No Manure.	2 cwt. N.	2808	7776	5324	5358
2	1½ cwt. N. 2½ cwt. P. 1 cwt. K.	2 cwt. N.	8810	8742	9874	5735
3	2 tons M. 1 cwt. N. 2 cwt. P.	2 cwt. N.	5953	8823	7600	5663
4	1½ cwt. N. 2½ cwt. P.	2 cwt. N.	8810	8098	7648	4985

NOTES ON TABLE.

N = Sulphate of ammonia.
P = Superphosphate.
K = Sulphate of potash.
M = Vacuum pan molasses.

The sour grass yields for the black soil centre are poor for 1930 owing to the scanty rainfall which fell.

The mean yield for Plots 2 and 3 shows an increased weight of grass over Plot I at both red and black soil centres for the second year although all three plots received a similar dressing of manure. This increase in yield is significant at the red soil centre, but cannot be judged significant at the black soil centre. It is evident therefore that the manures applied to Plots 2 and 3 in the first year were not entirely exhausted by the two crops of sour grass removed in 1929 at the red soil centre.

(3) PLANTATION EXPERIMENT.

The results of some single plot manurial trials carried out on sour grass by two plantations were kindly sent in to the Department and the yields obtained for the first cutting are set out herewith.

Plot.	Treatment per Acre.	Plantation I.		Plantation II.	
		Yield (per acre) lb.	Plot I. = 100	Yield (per acre) lb.	Plot I. = 100
1	Unmanured.	6187	100	4620	100
2	N	20050	324	7280	158
3	N + K	21530	348	9440	204
4	N + P	22520	364	12480	270
5	N + P + K	24260	392	9820	213
6	K	5940	96	5540	120
7	P	4455	72	5200	113

NOTES ON TABLE.

N = Nitrogen as sulphate of ammonia.
P = Phosphoric acid as superphosphate.
K = potash as muriate of potash.

As shown by other experiments it is evident that nitrogen is the main nutritional factor influencing the yield of sour grass on the typical Barbados

grassland. Potash and phosphoric acid alone have little if any effect on the yield, but nitrogen with phosphoric acid or potash appears to give a greater increase in yield of grass than nitrogen alone. Both potash and phosphoric acid are needed on the typical Barbados grassland in addition to nitrogen if the maximum weight of grass is to be obtained.

SECTION III. SOILS.

It was pointed out in last year's report that the soil types in Barbados are relatively few and hence an attempt has been made to carry out an intensive type of soil survey in order to build up an advisory system on the basis of manurial trials and soil analyses.

During the year soil samples have been taken from twenty-seven plantations and, usually, a composite has been taken from each of three or more fields. On each soil sample determinations have been made of loss on ignition, index of texture, alkali soluble humus, total carbon, total nitrogen, calcium carbonate, water soluble phosphoric acid, exchangeable potash and total exchangeable bases. With the aid of these figures and the data deduced from the variety and manurial trials, as reported last year, advisory soil reports have been written and sent out to the plantations concerned.

The following information which is additional to that contained in last year's report is of interest in connection with the investigations made.

1. TOTAL EXCHANGEABLE BASES.

Kelly & Brown (3) have shown that if a soil is leached with a solution of ammonium chloride, the total content of bases present in a replaceable form can be exchanged for ammonia. The amount of ammonia thus absorbed by the soil can be readily estimated after leaching out the excess ammonium chloride and hence the equivalent of the replaceable bases can be calculated. All of the soils which have so far been examined in Barbados have been alkaline in reaction and have contained reserves of calcium carbonate. It is therefore probable that the total replaceable bases as determined by the ammonia absorption figure will be a comparative measure of the total exchangeable capacity of these soils.

The equivalent of the total replaceable bases has been determined for 157 soil samples with the results set out below.

Total Replaceable base (mgrm. E. per 100 grm. soil).

Soil Type.	No. of Determinations.	Minimum.	Maximum.	Mean.
Black Soils ..	58	25.6	63.1	48.4
Red Soils ..	62	18.7	47.7	28.4
Red Sand Soils	27	9.8	26.8	19.5
Scotland Soil..	10	22.0	42.0	27.9

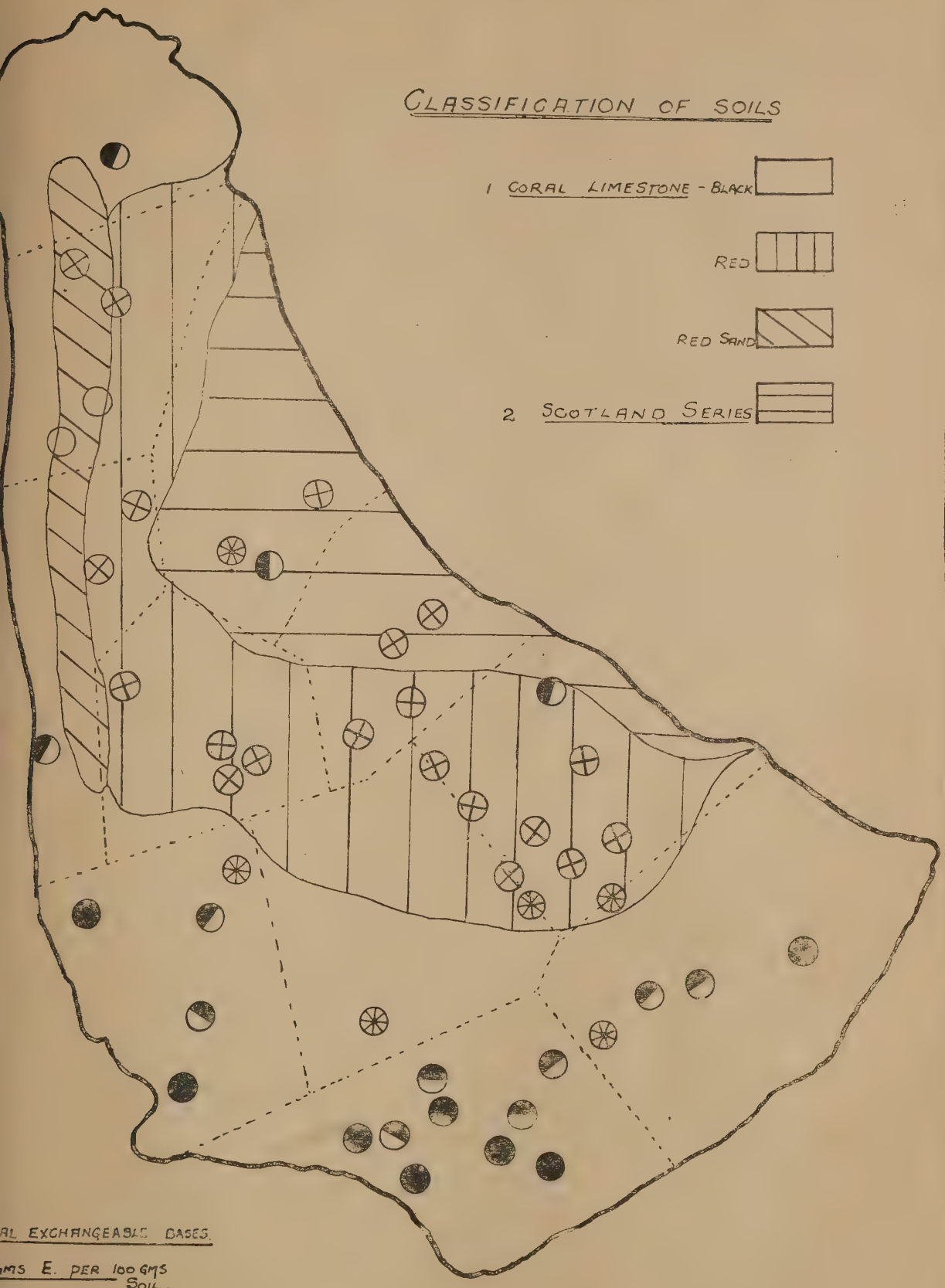
Distribution of Total Base (mgrm. E. per 100 grm. soil).

Soil Type.	10—20	20—30	30—40	40—50	50—60	Over 60.
Black Soils ..	..	3	10	17	24	4
Red Soils ..	2	42	12	6	..	..
Red Sand Soils	13	14	..	..	..	..

The distribution of the replaceable base figures on a map of Barbados showing the various soil types is given in Plate XI. Each spot represents the mean of several replaceable base determinations made on soil samples taken from the area covered by the spot.

Consideration of this map and the data given in the above tables show quite clearly that the black soils contain a higher proportion of exchangeable bases than do the red soils and the red soils contain more exchangeable bases than do the red sand soils. If the figure denoting total replaceable bases can be used as a measure of the amount of soil colloids, then it would be expected

PLATE II.


CLASSIFICATION OF SOILS
1 CORAL LIMESTONE - BLACK
RED
RED SAND
2 SCOTLAND SERIES
AL EXCHANGEABLE BASES.
MS E. PER 100 GMS SOIL.
50-60
40-50
30-40
20-30
10-20.

that the black soils would be more colloidal than the red and that the red soils would be more colloidal than the red sands. This conclusion is indicated by the field behaviour of these soils.

2. EXCHANGEABLE CALCIUM.

It would be expected that, on these coral limestone soils with their reserves of calcium carbonate, the exchangeable bases would consist mainly of calcium. This expectation is borne out by experiments. The amount of exchangeable calcium for three soils, and in each case calcium contributes over 70% of the total exchangeable bases, is shown herewith.

Soil Type	Exchangeable Calcium (Mgm. E.)	Total Exchangeable Base (Mgm. E.)	Percentage Calcium in Total Base (Mgm. E.)
Black	24.92	35.30	70.6
Black	30.53	39.00	78.3
Red Sand	9.30	12.60	73.8

3. INDEX OF TEXTURE.

It was shown in last year's report that the index of texture figures are very similar for both red and black soils. This is well brought out below where the distribution of index of texture figures for those black, red and red sand soil types which have so far been examined are set out.

DISTRIBUTION OF INDEX OF TEXTURE

Soil Type	0–9	10–19	20–29	30–39	40–44	44–55
Black Soils ..	..	..	2	44	6	..
Red Soils ..	..	..	2	53	1	..
Red Sand Soils	2	14	2	5	..	..

The index of texture figure was put forward by Hardy (4) as a single value constant for assessing soil texture. It is based on the moisture content of a soil at the point of stickiness and this is taken as a measure of the colloid content of the soil. Keen and Coutts (5) have subsequently shown that the moisture content of a soil at its point of stickiness is largely controlled by the organic and inorganic colloidal material in the soil.

In view of these facts it might be expected that there would have been a good correlation between the index of texture figures and the total exchangeable base figures. It is evident, however, that this is not the case since, although the index of texture figures for the red and black soils are very similar, the total exchangeable base figures are definitely higher on the black soils.

The similarity between the index of texture figures for red and black soils is supported by mechanical analyses which are very similar for red and black soils. (Vide paragraph 4). The behaviour of the red and black soils in the field, however, are more in accordance with their base absorbing properties and, from the practical standpoint, the red soils would be judged to have less colloidal properties than the black.

It appears that the inorganic colloidal matter of the red soils is of a different nature to the inorganic colloidal matter of the black soils. This matter is being further investigated.

4. MECHANICAL ANALYSES.

As time permits, mechanical analyses are being carried out on composite soil samples which have been stored at the Laboratory, as representative of

different districts and plantations. The mean results which have been obtained to date for black, red, red sand and Scotland soils are given below and although the number of analyses is as yet limited the figures will serve to show the main features of the mechanical analysis of the different soil types.

SOIL TYPE.

Fractions, etc.	Black Coral Limestone.	Red Coral Limestone.	Red Sand Coral Limestone.	Scotland
Number of Determinations	8	8	2	5
Coarse Sand	2.1	1.7	25.3	4.2
Fine Sand	12.4	8.5	34.6	23.8
Silt	29.4	20.0	3.8	24.5
Clay	40.6	57.8	31.7	37.5
Moisture	6.6	4.5	3.6	4.2
Calcium Carbonate	4.1	2.2	0.5	4.7
Loss in Solution	2.9	3.2	0.9	2.2
Total	98.1	97.9	100.4	101.1
Index of Texture	36.8	34.1	12.0	33.1
Total Replaceable Bases ..	48.9	28.7	16.2	26.6

It will be seen by reference to this table that the black and red soils have very similar mechanical analyses. In both cases the silt and clay fractions amount to about 70%. In the red sand soils the coarse and fine sand fractions predominate, whilst in the Scotland soils the fine sand, silt and clay are the chief fractions.

5. CARBON AND CARBON NITROGEN RATIOS.

During the past year the determination of total carbon has been made on a number of typical red and black soils and the ratio of carbon to nitrogen in these soils has been calculated. The results are set out herewith.

		Total Carbon.			Carbon-Nitrogen Ratio.		
Soil Type.	No. of Determinations.	Minimum.	Maximum.	Mean.	Minimum.	Maximum.	Mean.
Black Soils ..	34	0.61	1.77	1.08	4.8:1	12.9:1	8.4:1
Red Soils	15	0.94	2.07	1.54	5.2:1	11.2:1	7.7:1

There is little doubt that, on the average, the red soils have a significantly higher carbon content than the black soils. This is most probably the indirect result of the heavier rainfall which is always experienced in the red soil districts. The greater rainfall results in greater yields of cane per acre and hence a greater fall of trash. In addition, owing to the moister soil conditions, it is possible, to ratoon cane in the red soil districts which practice necessarily increases the yield of trash per arable acre. With the exception of estates which are well provided with sour grass pastures, the trash from the sugar cane is the most important source of soil organic matter. Hence, in the red soil areas it is possible to return more organic matter per arable acre than it is in the black soil areas.

The carbon-nitrogen ratios for the soils examined vary between 4.8:1 and 12.9:1 and the variation is as great for red as for black soils. The mean value of the carbon-nitrogen ratio for all the red and black soils examined is 8.2:1.

6. THE ALKALI SOLUBLE HUMUS AND THE TOTAL ORGANIC MATTER.

As a measure of the soil humus it has been customary to determine on all samples that portion of the organic matter which is obtained from the acid extracted soil by cold alkali. In order to estimate how well this portion is related to the total organic matter as calculated from the carbon, the correlation has been worked out for the fifty-nine pairs of values so far determined. The mean value of the alkali soluble humus for the fifty-nine soils is 0.49% and the mean value of the total organic matter for the same soils is 2.11%. The correlation coefficient for the fifty-nine pairs of values is—0.205. When tested, this negative correlation is not found to be significant. It follows then that for the soils so far examined there is no correlation between the total organic matter and the alkali soluble humus.

It might be noted that, in estimating the alkali soluble humus, the extract is compared with a standard solution of humus prepared from a composite sample of local soils.

7. THE RELATIONSHIP BETWEEN THE RED AND BLACK SOILS.

There seems little doubt that the genesis of the red and black soils has been very similar since they both overlie the coral limstone. There is no strict line of demarcation between the red and the black soils. The reddest soils are found at the highest altitudes in the regions of greatest rainfall and the blackest soils are found at the lowest levels in the driest districts. Between these extremes are all gradations of colour with the result that the coral limestone soils could be and have been classified as Blacks, Intermediate Blacks, Intermediate Reds and Reds. The difference in colour is not due to the presence of more organic matter in the black soils. It has been shown that the red soils, on the average, contain more organic matter than the blacks and it is also found that the black soils retain their colour after treatment with hydrogen peroxide.

It would appear that the differences between the red and black soils are, for the main part, due to differences in maturity. The red soils are the oldest since they are found at the greatest elevations and the intermediate soils, from their position, would be judged intermediate in age between the red and black soils. It would be expected, therefore, that the red soils would be more mature than the black soils.

The physical and chemical properties of the red and black soils so far examined would also suggest that the red soils are more mature than the blacks. It has been found that the clay fraction of the black soils has a higher alumina/silica ratio than the clay fraction from the red soils. This lower ratio in the red soils possibly accounts for the lower base absorbing power of red soils when compared with black soils of similar mechanical analysis.

In the field the red soils, in general, behave as if they contain less colloidal matter; they are more easily worked after rain than the black soils and they are more quickly affected by drought.

SECTION IV. SOME ASH ANALYSES OF SOUR GRASS.

(*Andropogon pertusus*).

In last year's report the composition of sour grass as far as moisture, protein, fat, carbohydrates and fibre were concerned was dealt with in some detail and the variation in the average composition at different times of the year was given.

During the year under review a series of analyses have been carried out on the ash of a number of sour grass samples with the results set out in the following table. For the sake of comparison the ash analyses of "all grazed" natural pasture, "partly grazed" poor hill pastures, and pasture from the Falkland Islands, given by Orr (6) and the ash analyses of savannah grasses and mixture pasture grasses given by Follet-Smith (7) are also incorporated in this Table.

MINERAL CONTENT OF SOUR GRASS (ANDROPOGON PERTUSUS).

PERCENTAGES ON DRY MATTER.

	No.	Date cut.	Total Ash.	Silica Free Ash.	CaO	MgO	Na_2O	K_2O	P_2O_5	Cl	N	Fibre.
	L 6 ..	7.1.30	10.30	1.23	0.47	0.54	0.14	0.08	0.14	0.02	0.58	32.00
	L 15 ..	16.1.30	13.00	1.71	0.50	0.30	0.34	0.12	0.21	0.08	0.47	39.17
	L 44 ..	12.2.30	11.03	1.80	0.37	0.42	0.20	0.07	0.19	0.04	0.43	32.05
	L 45 ..	12.2.30	11.61	1.42	0.36	0.39	0.14	0.04	0.22	0.04	0.37	34.57
	L 77 ..	3.3.30	11.15	1.79	0.49	0.45	0.10	0.14	0.19	0.02	0.41	32.53
	L 78 ..	3.3.30	9.88	1.61	0.55	0.22	0.23	0.08	0.17	0.03	0.34	36.46
	L 89 ..	8.3.30	11.78	2.05	0.55	0.70	0.07	0.07	0.20	0.08	0.34	34.60
	L 173 ..	6.4.30	11.04	1.70	0.80	0.20	0.09	0.04	0.13	0.08	0.41	30.43
	L 191 ..	12.4.30	9.70	1.84	0.73	0.15	0.02	0.05	0.09	x	0.34	31.34
	L 331 ..	13.6.30	7.56	1.36	0.46	0.49	0.02	0.05	0.14	x	0.59	40.40
	L 450 ..	8.8.30	8.63	1.25	0.67	1.12	0.04	0.11	0.21	x	0.63	34.31
	MEAN ..		11.51	1.66	0.54	0.45	0.13	0.08	0.17	0.05	0.45	34.35
"Natural Pasture"			..	5.85	0.65	..	0.37	2.66	0.67	0.64	2.50	24.5
"Poor Hill Pasture" ..			..	5.49	0.56	..	0.41	2.60	0.60	0.60	2.54	25.2
Falkland Island's Pasture ..			..	4.56	0.29	..	0.31	2.20	0.54	0.70	1.95	29.3
Mixed Pasture British Guiana ..			10.55	4.75	0.30	0.85	..	1.61	0.92	0.56	1.38	..
Average Savanah Grass British Guiana			..	2.30	0.20	0.32	..	0.82	0.08	0.08	..	..

x Not yet determined.

It will be noted at once that the silica free ash of all samples of Barbados sour grass examined is very low when compared with English pasture grass, but that it approximates to that found in the savannah grasses of British Guiana.

In consequence of the low silica free ash it follows that the individual constituents will also be lower than those recorded for English pasture grass. On examination of the figures, however, it will be noticed that the percentage of lime in the dry matter is very much higher whilst the percentage of potash is much lower than would be expected.

The ash constituents have been recalculated as percentages of the silica free ash and some interesting features are brought out below. The very low percentage of potash in the sour grass ashes is at once apparent. This small amount of potash is possibly associated with the fact that the Barbados grasslands have remained unmanured for as much as fifty or more years. In addition, it has been shown by the manurial trials carried out on arable land with sugar cane that the coral limestone soils are very apt to run short of potash if potash manuring is not sufficiently liberal.

The next feature of note in these sour grass analyses is the high percentage of calcium in the ash. This is perhaps explicable when the high content of lime in the local soils is considered.

Although the percentage of phosphoric acid on the dry matter varies considerably in the grasses from the various countries, it is interesting to note that with the exception of the savannah grasses from British Guiana, the percentage on the silica free ash does not fluctuate to any marked degree.

There is little doubt that imported stock fed entirely on sour grass would suffer from mineral deficiency diseases. The fact that mineral deficiency diseases are not apparently present in Barbados amongst milch cattle and working stock is probably due to a number of causes amongst which may be mentioned the following:—

(a) Sour Grass is only fed for part of the year as the principal rough forage. Sugar cane tops and other forage crops grown on manured arable land are fed during the remainder of the year and the ash constituents of such crops should be sufficient in amount and balance.

(b) Sour grass is never fed alone to milch cattle or working stock. It is supplemented with vacuum pan molasses, generally supplied *ad lib.*, and a small amount of concentrated food. Vacuum pan molasses contains about 10% of ash and the approximate composition of this ash is given herewith.

(c) As far as sodium and chlorine is concerned it is customary to supply all stock with "salt licks."

MINERAL CONTENT OF SOME FOODS.

PERCENTAGES ON SILICIA FREE ASH.

Food.	CaO	MgO	Na_2O	K_2O	P_2O_5	C_1
Barbados Sour Grass	32.5	27.1	7.8	4.8	10.2	3.0
Natural Pasture ..	11.1	..	6.3	45.5	11.5	10.9
Poor Hill Pasture ..	10.2	..	7.5	47.3	10.9	10.9
Falkland Islands Pasture ..	6.4	..	6.8	48.2	11.8	15.4
British Guiana Pasture ..	6.3	17.9	..	33.9	19.4	11.8
Average of British Guiana Savannah Grass	8.7	13.9	..	35.7	3.5	3.5
Vacuum Pan Molasses ..	8.5	2.4	2.7	46.7	1.8	7.2

SECTION V. GENERAL ANALYTICAL WORK.

A total of 1007 samples were examined at the Government Laboratory during 1930—This represents a slight increase over 1929. They comprise:—

(a) *Police Department.*

Viscera and examinations for poisonous substances	35	
Milks	121	
Counterfeit coins	11	
Rum	42	
Food and Drugs	20	229

Five samples each of Viscera were submitted in connection with two post mortem examinations. In one case death was caused by a large quantity of nitrobenzine which was drunk by mistake for rum. In the other case no poison was found in any of the organs.

A quantity of powdered glass was separated from two samples of cooked food submitted.

Fifteen grains of white arsenic were separated from a sample of cooked fish.

A sample of water suspected to contain poison was found to contain a quantity of sodium carbonate (washing soda).

Eleven exhibits of clothing submitted in connection with acid throwing were examined. The liquid in each case was found to be concentrated sulphuric acid.

While the number of samples suspected to contain poison is rapidly increasing, the majority of samples are, however, generally free from harmful ingredients.

The number of samples of local milk submitted show a decrease of about 50 per cent. The percentage adulteration was 17.3 as against 11.5 for 1929.

Of the coins submitted, two were genuine.

Thirty-three per cent. of samples of rum submitted were below legal strength. This represents an improvement over 1929 when the percentage of adulterated samples was 51.

Of the samples taken under the Food and Drugs Act—comprising chiefly Teas and Cocoas,—more than 50 per cent. were adulterated or deficient in an essential constituent. In the absence of a revised Food and Drugs Act, or the fixing of standards for certain articles of food, it will be very difficult for the Police to prove this adulteration.

(b) *Customs Department.*

Condensed Milks	11
Petroleum	233
Miscellaneous	12

The condensed milks were uniform in quality—only one failed to come up to the standard prescribed by English regulations.

All kerosine oils submitted for flash point were within the limits of the Petroleum Act.

The increase in the number of petroleum samples is largely due to the number of samples of Gasolene submitted for the first time this year. In order to arrive at a correct assessment of Customs duty, the Specific Gravity and then the weight per gallon of each shipment of gasolene is now determined at the Laboratory. The variation in gravity though not serious, certainly justifies this procedure.

Samples of Fuel oil for flash point determination were also submitted for classification. It is suggested that the present ambiguity in the Customs Tariff Act which permits Solar and Diesel oils flashing above 150°F. to be classified with Residue oil should be removed.

The miscellaneous samples under this head comprise chiefly Spirituous liquors for assessment of their alcoholic content and wood and spirit naphthas for their suitability as denaturants. Here also consideration may be given to the fact that Wood and Spirit naphthas are very expensive denaturants, and can with advantage give place to more efficient and cheaper denaturants.

One sample opium was submitted.

(c) *Department of Science and Agriculture.*

Feeding stuffs	48
Waters	12
Insecticides	5

The analyses of a large number of fodders (chiefly sour grass) were made in connection with the grass manurial experiments of the Agricultural Chemist. Kernel and oil contents of the locally grown Sunflower seeds were also made; a great reduction of oil and kernel content has been observed in them as compared with the original seed.

The waters examined consist of the monthly rainfall samples collected at the Codrington Meteorological Station.

Insecticides comprise chiefly Paris green and kerosene emulsion sprays.

(d) *Waterworks Department.*

Waters	5
Fuel oil	3
Flue gases	8

The quarterly analyses of water as supplied by the Department from its mains were made as well as a sample from College. The usual uniform high quality was maintained.

Analyses were made and Calorific values determined of the fuel oil supplied to the Pumping Station.

Flue gases were examined for Carbon dioxide in connection with tests made on Furnace and Boiler equipment at Belle pumping station.

(e) *Agricultural Society.*

(Analytical Committee)	
Fertilizers	58
Feeding stuffs	51
Sugars and molasses	71

The fertilizers and feeding stuffs were submitted under Fertilizers and Feeding Stuffs Act. A good standard of quality of both products was maintained. It must be noted that under the Act a guarantee must be given when sample is purchased. This guarantee should be insisted upon and steps should be taken to bring these Acts in line with the standards laid down by the English Acts.

The sugars and molasses were examined in connection with the award of prizes at the Annual Industrial Exhibition. For the first time the sampling and examination were made under the new regulations adopted by the Society. Percentages of mud in Fancy molasses were determined, and two examinations made on each sample early and late in the year respectviely.

(f) *Miscellaneous (Official).* 32.

The miscellaneous analyses and investigations carried out include:

(1) Examination and report on samples of food submitted by Sanitary authorities. In this connection 2 samples of salted beef were found unfit for human consumption.
(2) Quarterly analyses of waters supplied from well at Mental Hospital —a high quality was maintained.
(3) Experiments were carried out on the determination of small quantities of Sulphur dioxide in Cane syrups, and a method of estimation arrived at.
(4) A number of samples of milk was examined for fat in connection with feeding experiments by the Agricultural Chemist.
(5) An investigation into and correction of the Laboratory standard for Beaume hydrometers—the scale adopted is that according to Gerlach with modulus 146.78.

(g) *Unofficial Samples.*

Fertilizers and Feeding stuffs	26	
Syrups and Molasses	44	
Cane juices	73	
Spirituous liquors	9	
Tea and cocoa	8	
Waters	17	
Hydrometers for calibration	18	
Miscellaneous	34	229

The miscellaneous items under this head include milks, limes, fuel oils, filter press cakes, boiler compounds and drugs.

SECTION VI.- THE ANALYSIS OF SUGARS AND SYRUPS.

The analyses of samples of sugar and syrup sent into Bridgetown from the factories were continued. In view of the diminished crop this year the number of samples show a considerable decrease. A total of 22,136 samples have been analysed to date (June). These comprise 12,543 sugars and 9,593 syrups. The sugars show a decrease of 59 per cent. over those of 1930—the syrups an increase indicating that still more syrup and less sugar have been manufactured this year as compared with 1930.

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Chapter IV

ENTOMOLOGY.

REPORT OF THE ENTOMOLOGIST.

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ENTOMOLOGY.

REPORT OF THE ENTOMOLOGIST.

R. W. E. TUCKER, M.A., B.Ed.

SECTION I. INTRODUCTION.

The year, July 1930, to June 1931, has seen continued progress in all branches of Entomological control. The control of noctuid larvae, particularly of the army worm variety, and a more adequate control of scale insects has been stimulated by importing light, easily handled up-to-date spraying and dusting apparatus, demonstrating their use and lending them free of charge to planters and gardeners and arranging for adequate supplies of correct spraying and dusting materials. Cotton has been successfully grown in spite of drought; and pink bollworm appeared so late in the season and in such small numbers as to demonstrate the success of the control measures now in force. Planters again co-operated well in the collection of newly emerged adults of the root-borer *Diaprepes abbreviatus* and definite results have been obtained. In addition to a continuation of this work it is the intention to introduce the egg parasite *Tetrastichus haitensis* through Dr. J. G. Myers, Entomologist in the West Indies to the Empire Marketing Board.

The control of the cane moth borer *Diatraea saccharalis* by means of mass rearing and liberating *Trichogramma minutum* has proceeded on normal routine lines, though the hopes of obtaining a clearly demonstrable control of the pest over the whole island have been vitiated by the abnormal heat and drought of the period under review. This not only resulted in temperatures inimical to the breeding of the moth *Sitotroga*, resulting in a diminished output of *Trichogramma*, but was also far more adverse to *Trichogramma* in the field than to its host. The weather in fact with its uniformly high temperatures and absence of heavy rains, but preponderance of light showers useless for agricultural needs was distinctly favourable to all insect life; army worms and cotton worms for example were present in far greater abundance than normally and there is no doubt that *Diatraea saccharalis* was similarly favoured. For these reasons, coupled with a very short and abnormal cane crop in all coastal areas, the optimum results from the use of *Trichogramma* had little chance to materialise. As shown later, however, distinct progress was made.

More extensive factory and field examinations of the crop reaped in 1931 were made this year, for it is necessary to obtain as accurate an idea as possible of the losses caused by any insect pest which is under control in order that the economy of the measures employed to control it may be evaluated. When the work reviewed below is considered in relation to the losses suffered by the sugar industry through the depredations of *Diatraea saccharalis* there is no doubt that the breeding of *Trichogramma* and general insect control work is on an economic basis in Barbados. At least 20% of the sugar grown in the Island can definitely be proved to be destroyed by moth borer; at a conservative estimate this amounts to £200,000 annually. To save this loss a sum not exceeding £1,800 is spent annually on insect control. This sum includes all salaries as well as some capital, non-recurrent expenditure, and the work of the Entomologist includes the control of other major pests, and not moth borer alone. It is not claimed that the whole of the loss due to moth borer can be saved, but supposing that it is reduced by only 25%—which is a very modest control—there will still be a saving of £50,000 annually for an expenditure on this work of a proportion of £1,800 annually. Moreover, given normal seasons of temperature and rainfall, it is hoped to obtain a reduction of more than 25% in the annual loss resulting from moth borer.

In connection with the mass breeding of *Trichogramma* against *Diatraea*, I wish to record my thanks to Mr. S. E. Flanders of the University of California for sending several strains of *Trichogramma* for use here.

In general Entomology a considerable amount of advisory work has been carried out and general pest control is as detailed.

The 3rd Imperial Entomological Conference held in London in June 1930 was attended, special leave being granted for this purpose.

SECTION II. CANE MOTH BORER.

AN ACCOUNT OF DIATRAEA SACCHARALIS AND OF THE TECHNIQUE OF BREEDING TRICHOGRAMMA MINUTUM AND OF THE RESULTS OF TWO YEARS FIELD LIBERATIONS OF THIS PARASITE IN BARBADOS.

General Discussion.

Preliminary accounts have already been published in Tropical Agriculture Vol. VI., No. 8 and Vol. VII. No. 11, (58) and (59). The following account is illustrated and details inclusive of costs given to demonstrate the economy of mass production of *Trichogramma*, its easy routine manipulation and its effectiveness. It is not at present claimed that mass liberations of *Trichogramma* will do more than maintain an annual economic control over *Diatraea*. The results obtained from present operations and expenditure justify not only the continuation of the work in Barbados, but any expansion of the work which may be possible. Experience has shown that the more frequent the liberations, the more effective is the control over the area treated, and every effort has been and will be made to increase the output of parasites by additional units, increased corn supplies and economy of time in the change over from units.

That the mass breeding of *Trichogramma* on an increased scale is justified is borne out not only by results in Barbados, incomplete as they are at present, but by the experience of other workers in this line in various parts of the world. Several workers, Flanders (16), (20), Hinds and Spencer (25), (28) and (30) in particular have shown that early and organised colonisations by *Trichogramma* have resulted in a definite increase in parasitism in the field and resultant control or partial control of the pest in the treated areas. This is undoubtedly the experience in Barbados. Reliance has been placed on building up at the earliest possible dates, field parasitism of *Diatraea* eggs at as many foci as possible and on maintaining an increased parasitism over a period of several months. The area treated amounts to approximately 35,000 acres of cane, and liberations of from three to seven million parasites are made monthly, approximately a third of the above area being treated each week. Each area thus receives parasites once every three weeks or less. It is realised that this is inadequate for the area treated but it has been impossible to limit and concentrate the distribution and refuse parasites to any particular area. It was equally impossible to start off with the numerical production of parasites which is necessary and which it is hoped gradually to attain. Nevertheless, it is considered that the present procedure will meet with increasing success, which would be enhanced if the recipients of parasites would examine the young cane fields first and place the parasites out in the fields containing a brood of newly deposited *Diatraea* eggs instead of in the fields unattacked or devoid of all but empty eggs. The loss of parasites in the early part of the year, owing to planters putting them out into fields which contain no available *Diatraea* eggs for oviposition is a serious but at present unavoidable, drawback to the work; for moth borer attack is by no means uniformly or impartially distributed. The immediate increase in parasitism in fields suitable for liberation is however indisputable.

In this connection some remarks may be made on statements which have appeared in print as to the effectiveness of the work of *Trichogramma* and with which the writer cannot agree. It has been stated that because there is usually a large natural mortality among the *Diatraea* larvae which hatch, and because only a relatively small proportion of larvae succeed in entering the canes, that therefore *Trichogramma* only prevents from hatching larvae which would die in any case. Further, it has been stated that because now and again the parasite misses an egg or two in a cluster (a very rare occurrence in the many thousands examined by the writer) that the parasitism is largely ineffective because if only one or two larvae escape, they are all that are needed to kill a developing cane.

Both of these statements are unjustifiable because the natural factors which operate to kill say 90% of the larvae which normally hatch will operate to practically the same extent on the part as on the whole, and therefore the reduced number that succeed in hatching out, will have no greater chance of success in surviving to enter canes than would individuals of a larger hatch. It is hardly

justifiable to state that if two or three eggs escape parasitism out of a cluster of 30, or if say 30% of the total clusters deposited escape parasitism, that the larvae thus emerging will be immune or even less susceptible to natural mortality factors, thus decreasing the effectiveness of the egg parasite. If anything, the opposite would be the case. In Barbados the environmental conditions over the major portion of the island are fairly homogeneous, and the *proportion* of larvae destroyed by factors independent of *Trichogramma* should therefore remain constant. Further, the host *Diatraea* is not one which is spreading rapidly or increasing in numbers; therefore the increased destruction of eggs by *Trichogramma* should eventually reduce the host population below the damaging level which it had reached. Moreover, there is a possibility that the host may remain stabilised at this lower level owing to the operation of natural mortality factors which, as stated, would take effect independently of the number of larvae hatching out.

When considering the scheme for reduction of moth borer damage by means of the mass breeding of *Trichogramma*, it must be borne in mind that *Diatraea saccharalis* (and its allied species) is one of the most difficult pests to control. Dusting or spraying the cane crop is neither effective nor economic; cultural methods such as clean seed selection, soaking of seed, deep planting, cutting out of dead hearts, cleaning of reaped fields, etc., are valuable aids in lessening infestation, but have been proved unable in themselves to control the pest. Light traps and poison baits are ineffective, though they may have their uses in the protection of small, isolated areas of valuable seedling canes, and possibly for concentrating moths to form centres of heavy egg deposition whereat parasites can be liberated.

There remains only parasitic control, and that at present is the principal line of attack.

The control, if achieved, may come through the introduction of new parasites, or by breeding and distributing *Trichogramma* on an adequate scale.

The former class of parasites are larval, and occasionally pupal parasites, and, though these may in a few cases be artificially fostered for a time to increase the numbers liberated, they cannot be mass reared. They must rely on their powers of adapting themselves to, and becoming permanently established in, new surroundings; and in that they fail more often than they succeed. *Trichogramma* is not only a widely distributed egg parasite, but it is excellently adapted to mass rearing and distribution; its continued presence can therefore be guaranteed, and its effective work, though perhaps not as sweeping as first enthusiasm expected, is nevertheless certain.

Larval and pupal parasites undoubtedly have their uses and the writer endeavours to obtain and utilise them as far as possible in conjunction with *Trichogramma*, so that should any of them prove capable of establishing an ascendancy over, or even an economic balance with *Diatraea saccharalis* at its re-reduced level of population, the mass rearing of *Trichogramma* could be discontinued.

As previously described (58), larval parasites have been introduced to Barbados in large numbers from British Guiana (7) but have not become established, and *Lixophaga diatraea* has been recently introduced from Cuba, but after a year has not yet been recovered. It is hoped, however, to repeat the introduction of the latter parasite.

When considering larval and pupal parasites, it must be remembered that British Guiana has a record of 13 indigenous parasites of moth borers including two egg parasites (the same as present in Barbados), ten larval parasites and one pupal parasite. In addition, the Cuban Tachinid *Lixophaga diatraea* was introduced there in 1925, but does not appear to have made notable progress. In spite of this formidable array of larval and pupal parasites, borer infestation is very high in British Guiana and, according to figures given in 1928 (11), 95% of the stalks are damaged to the extent of 25% of the joints. When, in addition to the above indigenous and introduced larval parasites, collection of egg masses in growing cane, cutting out of dead hearts, and breeding *Trichogramma* and *Prophanurus* in eggs laid by moth borers hatched from such dead hearts, also cultural practices including selection of seed cane or soaking for 72 hours before planting are carried out in British Guiana, it can well be said that *Diatraea* control is a most difficult problem.

Larval parasites are apparently more effective in Cuba than elsewhere, but even there Plank (47) states that "unfortunately the effectiveness of these

parasites is confined to certain seasons of the year when apparently favourable climatic or other natural conditions prevail. There are thus periods when most of the parasites are comparatively inactive and the borer is left without any effective natural check. If we had parasites that would be active during these periods, we could expect that they would be at least as effective as those already present;" and that "we need parasites that will fill in the gaps between our native species, and thus complete the sequence of borer parasites throughout the year."

The writer's policy is to make the native species *Trichogramma* effective throughout the critical growing period of the cane crop, and to establish *Lixophaga* (the most effective of known *Diatraea* larval parasites) to work on the larvae in the young cane crop. At this period *Trichogramma* is least effective unless very great numbers are available for distribution, but *Lixophaga* is at its most active and effective period. This does not mean that *Trichogramma* is not to be liberated at that period, but equipment and conditions have not yet enabled the writer to produce a vast number of Trichogramma to distribute regularly through the young cane, and yet to obtain and maintain a peak production in June, July and August (and possibly later) when maximum cane growth and borer damage take place. It might appear that a reduction in *Diatraea* population through the operation of *Trichogramma* would adversely affect the chances of success on the part of *Lixophaga*. The writer considers, however, that even with a greatly reduced borer population to that which still obtains, there should still be some hundreds of partly to fully grown larvae to an acre of cane at any period; and as the cane stems are easily accessible to a strong flier such as a Tachinid, that therefore *Lixophaga* has at all times a fair field in which to operate and establish itself.

Dr. W. R. Thompson, one of the highest authorities on insect parasite work, has, however, stated (55) that "the fact that a relatively small proportion of the pest population is inaccessible may, in certain cases, completely prevent a parasite from establishing control. The total proportion of inaccessible pests must be very low if control is to occur." This would explain the inability of *Lixophaga* to exert more than a partial, sporadic, and seasonal control as described by Plank and other writers; for a considerable proportion of the larvae in large cane stems must be inaccessible to the larviparous *Tachinid*.

On the other hand, the eggs of *Diatraea* are openly exposed and reasonably accessible at all times to *Trichogramma*; hence the writer's contention—that of all the methods available for attempting to control *Diatraea saccharalis*, that of mass rearing and liberating *Trichogramma* offers the greatest chances of success.

It can at least be said that so far as Barbados and its topography and conditions are concerned, no other known method could have given the results already obtained in the time and for the money expended; and no other methods promise immediate alleviation at an economic cost even though complete control of this stubborn pest may still be out of reach for a few more years.

The Prevalence of Diatraea saccharalis.

Although *Diatraea saccharalis* is prevalent throughout the Island, the losses caused by it do not appear to have been fully realised, or else, until the last two years they have been accepted as a natural and unavoidable occurrence, attendant upon the growing of cane. No control measures were in operation in 1928 (larval parasites imported in 1926—7 failed to become established) and the pest has been in general assisted rather than combatted by prevalent agricultural practices.

The use of "borer gangs" to collect egg masses and to cut out dead hearts in young cane has been tried but has never been established in Barbados.

The soaking of plant cane to kill borer grubs and larvae prior to planting has been recommended, but is not practised, because proper facilities for adequate soaking of plants do not exist on most plantations nor has there been any universal or satisfactory hand selection of unbored cane, in order to avoid infesting plant fields from the time of their growth; it is only recently that the more progressive planters have paid serious attention to the latter method.

Further, under ordinary planting conditions it is necessary to intersperse blocks of young cane between blocks of unreaped cane, thus providing new fields in which the moth can carry on an unbroken cycle, and there are no huge unbroken stretches of cane planted at one time, as in larger sugar producing countries; a practice which tends to minimise borer damage.

Finally, fields of Indian corn are dotted amongst cane fields and ultimately left to dry out whilst standing. These corn fields are invariably badly infested with *Diatraea* and have been proved to increase borer infestation in neighbouring cane fields, owing to moths escaping from the dried out standing corn stalks.

The condition in 1928 prior to *Trichogramma* work was that the moth was uncontrolled save by natural conditions of weather, temperature, etc., and by the natural operations of the egg parasites *Trichogramma minutum* and *Prophanurus alecto*, and to a negligible extent by larval fungi. Insect parasites of borer larvae have never been found in Barbados, and as stated those introduced did not become established.

With regard to its life history, the cycle of the moth is normal for the West Indian region, namely egg period 6 days; larval period 21–30 days, pupal period 7–8 days. The number of eggs to a cluster varies considerably, 2 being the smallest and 100 the largest deposit found; the majority of clusters examined ranged from 10 to 30 eggs per cluster. An average computed from 350 clusters collected from various areas was 16 eggs to a cluster.

Degree of Infestation.

Diatraea saccharalis is distributed over the whole Island, but infestation varies according to the following factors:—(a) variety of cane, (b) whether plant or ratoon crop, (c) situation of field, (d) rainfall and temperature during growth of crop, (e) vigour of growth and size of canes, (f) stage of growth at which estimate of infestation is made, (g) initial infestation of field, whether from infested seed or from adjoining reapable cane, (h) number of liberations of *Trichogramma* made in or near to fields from which samples for estimates are taken.

The latter factor may apply only to Barbados, but other factors are fairly universal and will assist in making clear the natural difficulties, apart from technical or staff difficulties, in obtaining reliable and comparable annual estimates of the degree of infestation of *Diatraea* over large areas.

Briefly considering each factor, experience in Barbados shows that different varieties are attacked to different extents by the borer; to evaluate the differences in degree of infestation according to variety has been beyond the scope of our present organisation but the difference exists. With regard to plant or ratoon crops, it is the experience here, that eliminating other factors, first and second ratoon canes are less infested than plant cane. The situation of a field, whether sheltered or wind swept, (for wind carries *Diatraea* larvae) whether moist or rapidly drained, and flat or on the side of a hill, has its influence on the habits of the moth, and resultant degree of infestation. Salt (49) has shown that infestation lessens as one ascends a hilly field, and in Barbados, the central, hilly areas of the Island have till now always been considered by planters to be less affected by moth borer. These areas are also those of highest rainfall, and Walcott (63) has shown that rainfall is undoubtedly a factor in determining the degree of infestation by *Diatraea*.

The vigor of growth and size of the canes is also a determining factor, for not only are the moths more readily attracted to the shade and shelter of well grown canes, but experience during the drought of last season has shown that borers are more successful in their attack when the growth and vitality of the canes are weak; and that a uniform and satisfactory supply of moisture throughout the season, with resultant vigorous growth, is necessary for canes to withstand attack. The result of the drought appears to have been that moths were attracted to the fields of more normal, but nevertheless enfeebled growth, thus inflicting increased damage in such areas, whilst in the areas of sparse, short and unattractive cane growth, the lessened number of moths caused a relatively disproportionate damage. There is undoubtedly a relation between the vigour of the canes and the injury caused by a given number of moth borers.

With regard to the stage of growth of a crop such as cane, estimates of the degree of infestation should be made at the same or comparable periods for the same areas every year; for a difference of several weeks, even in a crop at the reaping stage, is bound to have an effect on results obtained.

Finally, initial infestation is, in Barbados, a very variable factor, and that, when considered in conjunction with the deposition or removal by wind

of newly hatched borer larvae, may largely account for the extreme variation in degree of infestation found in different fields and areas.

Loss due to Diatraea saccharalis.

The nature of the damage caused by moth borer to cane as delivered in factory yards and as standing in the field has been described by several writers (e.g.32) and further details are not necessary here. Estimates of the loss due to such damage have been made from time to time in various countries. The value of such estimates depends naturally upon the number and nature of the samples taken, the area involved, and consideration of the factors previously mentioned as governing the degree of infestation at any period, place and time. So far as Barbados is concerned, past estimates have been limited by the fact that at reaping time, when estimates of damage and loss are made, the pressure of work in connection with cane breeding experiments and results has not permitted the continued employment of trained field officers at the times or to the extent necessary. This year, to obtain adequate factory and field samples, different workers and different methods were employed and as far as possible the personal factor was eliminated so that future changes in the workers taking and estimating samples would not greatly matter. The results obtained, however, are not strictly comparable with those of the previous two years which were themselves comparable and have been previously given (59). Moreover, the abnormal nature of the crop examined, due to drought and heat would put it in a class by itself. Nevertheless figures such as percentage of joints bored and to a certain extent, the percentage of **total** loss, field and factory combined, are comparable, and they will be given later.

First of all, a brief survey can be made of the published losses recorded as due to moth borers in other countries. In many countries, more than one species of *Diatraea* is concerned; in Barbados, as far as at present known, only *Diatraea saccharalis* is present.

In Cuba Plank (47) records an average stalk infestation of 36.1%, an average internode infestation of 9.97% and a total loss of cane dead in field and loss due to damaged internodes, of 13.05% of the crop. Loss due to mortality in young shoots is not included. Considerable variation in infestation is recorded from the various areas examined; the percentage of canes infested varied from 0% to 98%; and internode infestation from 3.11% to 20.97%

In Louisiana the estimated loss due to *Diatraea saccharalis* is 19% to 20% of the full crop, rising occasionally to 30%. Another estimate Holloway etc. (33) places the loss of 96 test sugar at 1,082.33 lb. per acre.

In British Guiana, the damage done to moth borer is given by Cleare (11) as 95% of the canes damaged to the extent of 25% of the joints or internodes; the loss in cane rendered unreapable is not given.

In Mexico Flanders (16) records that 97% of the canes are infested to the extent of 25% of the joints; no mention being made of loss due to unreapable and rotten cane. Two species of *Diatraea* and the borer *Chilo loftini* are present in Mexico.

The estimates of loss in Barbados (59) and as given below indicate that in 1928 infestation was as severe as recorded anywhere save perhaps British Guiana and Mexico, but that since then a steady reduction in total loss has been achieved.

Method of Estimating Loss

This is now standardised for Barbados as follows. Twelve factories are selected as drawing canes from estates representative of the Island as a whole; and plant canes of the variety Ba. 11569 are selected as the standard to work with; if none are available at the time, then ratoon Ba. 11569 or plant B.H. 10(12) or B. 726 are taken. One thousand canes are taken at random from deliveries from at least five different estates; i.e. 200 canes from each. Each sample of 200 canes is divided into two groups of A and B shoots and C shoots; the former being the older, original growth canes and the latter the late season, rapid growth canes. The numbers and proportion of the two groups are recorded. The canes are then carefully examined and divided into groups of unbored, slightly bored and badly bored canes. A slightly bored cane is defined as having not more than five internodes showing not more than one or

two borer holes or external scars per joint. The majority of canes in this class would have only two or three joints affected; if five joints were very badly affected, the decision would rest with the officer in charge of the gang as to its class. Any canes with more than five joints affected would be put into the badly bored class. As each group of 200 canes was sorted, the numbers and weights of the canes in the three classes of the two groups (A and B, and C) were recorded, and the canes added to their respective groups in the main heaps.

At the end of the day's work the total numbers of unbored, slightly and badly bored canes were computed for the two groups combined and the relative proportions worked out.

A random selection of 150 canes for joint analysis was then made as follows. If 10% of the total canes were untouched by borer, then 10% of 150 or 15 unbored canes would be selected; if A and B canes were in the proportion of 2 to every 1 cane in the C class, then ⅔ of 15, or 10 canes, would be taken at random from the A and B unbored heap, and 5 canes from the unbored C heap; and similarly for all other groups.

The 150 canes selected would then, it is presumed, be adequately representative of the crop as a whole over the area served by the factory. These canes would then be weighed in their respective groups and brought to the laboratory for dissection joint by joint as described later. If two varieties of cane were sampled at any factory, then 150 canes would be taken of each variety.

By dividing the crop into the A and B, and C classes mentioned, some idea is obtained of the relative infestation of early and late developing shoots and a more accurate sampling of the crop is possible.

The 150 canes for joint and internode analysis are cut up joint by joint, and in any case of doubt, the joints are split into four. If a borer tunnel passed through a node and only slightly damaged the next internode, that joint or internode was classed as bored. From the records thus obtained of borer infestation in 2,250 canes examined, it was found that 27.3% of the total joints were bored. If unbored canes were excluded, and only the joint infestation of bored canes was considered, the figure was 30.0%. The corresponding figure for 1930 for bored canes only was 38.5%.

The estimate of loss due to cane rendered unreapable in the field was made as follows. One hundred and thirty-six fields representative of all areas of the Island, and including a majority of plant Ba. 11569 as well as most other varieties, were selected at random, and 100 stools in each field stripped of all trash. Workers then recorded the number of canes reapable, and the number unreapable. No attempt was made to ascertain the amount of cane rendered unreapable from causes other than borer; it is all classed as killed by borer or from the results of borer lesions, though possibly up to 10% is killed by other causes; for various reasons it is not possible accurately to sort out and define these other causes. At the same time, 20 stools out of each 100 are examined in detail and the number of unbored, slightly bored and badly bored canes recorded. The latter figures are regarded, however, more as a check on the workers' methods than as giving results worth considering, for it is rather difficult to examine and correctly classify canes which cannot be rotated or handled for examination. In all cases, the figures thus returned for unbored canes were far too high in comparison with the figures obtained from factory examinations and have not been taken into consideration.

The results obtained from this field examination of 13,600 stools, comprising 151,289 canes was 11.1% unreapable, and 88.9% reapable. The figures ranged from 4.3% unreapable to 21.2% unreapable; the areas with the lowest amounts of unreapable cane and the highest figures for unbored cane were invariably those of greatest parasite liberation.

Taking the figure 11.1% as being the field loss (exclusive of young shoots killed) due to borer attack, the factory loss amounts to 5.5% of the crop, and is computed as follows. According to Van Dine the average reduction in sucrose in joints due to borer damage is 20.2%; with an average joint infestation of 27.3%, the loss in harvestable cane is 27.3 x .202 or 5.5%. This added to the field loss makes the total loss 16.6% of the whole crop as estimated in 1931.

The estimated loss in 1929 was 31% and in 1930, 20.85% of the entire crop. Hence the loss of 16.6% in 1931 shows a steady reduction. It must be remembered however that the losses for 1929 and 1930 were estimated on a different plan (the same for both years) which necessitated too much detailed

work and expert supervision to be applied on a sufficiently large scale to sample the crop of the Island as a whole. Future results will be made comparable with the 1931 figures.

Nevertheless, though neither method is perfect, a sufficiently definite diminution in borer damage is revealed to show that a certain control is being obtained, and this is borne out by the evidence given later showing diminution in the number of *Diatraea* moths present, and increased parasitism of the eggs deposited by them; and by a lessening in the amount of damaged and rotten cane now left in fields at reaping time.

Diminiution in Loss Following Mass Liberation of T. minutum.

The conditions governing the natural action of *Trichogramma* on *Diatraea* have been summed up in (59). Field collections of *Diatraea* eggs up to May 1931 have confirmed the fact that young canes receive a heavy deposition of eggs from adjacent standing cane and that there is a small amount of parasitism by *Trichogramma* to windward of such cane, which diminishes further into the fields and ceases when the standing cane is reaped. By the end of March, when a considerable portion of the crop has been reaped, the number of eggs collectable in a given period drops rapidly; and simultaneously parasitism by *Trichogramma* drops to nearly zero. At this period, *Diatraea* is present principally as larvae in young shoots, and few eggs are laid in which *Trichogramma* can survive. Unless therefore as stated before, liberations of *Trichogramma* are made in fields known to contain newly deposited *Diatraea* eggs, the parasite is largely ineffective at this period. Liberations of *Trichogramma* are however made at this period, namely during May and part of April, for it has been proved to the satisfaction of the writer that a very considerable parasitism of eggs is obtained in sufficient fields to form foci of establishment for *Trichogramma*. By June, given normal rainfall and temperature, *Diatraea* hatch out in sufficient numbers, and the cane provides sufficient shelter, for native and laboratory bred *Trichogramma* to do very effective work in diminishing the number of larvae that emerge to take their chance of entering canes.

The evaluation of the results of this work over a wide area is a matter of considerable difficulty. As stated under the heading "Degree of Infestation" there are many factors which influence the degree of infestation; and to attempt to measure the effectiveness of *Trichogramma* by variation in the degree of infestation would mean that to obtain figures capable of statistical examination, adequate samples would have to be taken from practically every field in the Island; and that as an annual task is impossible.

It is possible however to obtain figures which indicate whether the numbers of moth borer and the damage done, are being reduced. Some of those have been given previously; others, obtained by regular collection of *Diatraea* eggs made as detailed in (59) and now increased by the work of a Field Assistant who regularly examines 35 fields throughout the Island at fortnightly intervals, have shown that fewer eggs are being deposited in the fields, and that parasitism commences earlier, and is higher than was normally the case. The result is a decrease in the number of the moths, and therefore it would be expected in the damage done. In this work at least 80 collections are made each month in an average of forty fields. Further indications can be obtained by the tonnage return of the crop as a whole, and by the almost universal opinions of Planters and Factory Managers bred for generations to the business of growing and making sugar.

With regard to the tonnage returns, the severe drought of last year resulted in the coastal areas of the Island reaping approximately 40% of the normal crop; the more favoured hilly regions fared better, and not only obtained almost a normal tonnage, but some estates exceeded it in spite of the fact that their rainfall was 15 to 20 inches under normal, which normal is in itself never more than barely sufficient for the crop. It may be mentioned that there have been no cultural or manurial changes, or new varieties of cane to which this increase could at present be attributed; it is considered however that the control of the root borer, *Diaprepes* and of the brown hardback *Phytalus*, as well as of *Diatraea* will have had a beneficial effect.

With regard to the opinions of the sugar growing and manufacturing community, it can be stated that since inauguration of control work by *Trichogramma* there have been (a) fewer dead hearts (save for an occasional bad field

here and there), (b) fewer tillers killed by borer during the growing season, (c) fewer badly damaged and rotten canes left in the field, (d) less discoloration of megass at the mills due to borer injury, (e) an increased purity of juice. These observations, voluntarily given, support all field observations indicating a reduction in moth borer attack. It is recognised that farmers or planters evidence is not scientific proof, and has often been proved not to be based on facts; nevertheless in the case of an industry centuries old and largely "bred in the bone" such evidence is certainly worth consideration.

Reference may be made to (c) namely that there are now fewer badly damaged and rotten canes left in the field. This points to a reduced moth borer attack, which is known to be responsible for the major percentage of such dead cane. At the same time it means that cane formerly so badly damaged that it was not reaped, and therefore not considered in factory estimates is now reaped and sent in; as a result, examination of cane in factory yards may show an actual increase in the percentage of borer damaged cane in factory estimates. In the writer's opinion it is necessary to make the factory yard estimates in order to draw a correct sample as outlined previously, which will adequately represent the entire crop of that area. It is however the internode analysis of these samples which gives the truest estimate of borer damage and, with "total crop" losses, and final tonnage reaped, give the truest estimate of the progress of control work.

It may be said that the value of *Trichogramma* work could be ascertained by a series of controlled field liberation experiments with sufficient replicates and controls for statistical analysis. To do this would be a full time project in itself which the writer could not carry out simultaneously with control measures, not only for lack of staff, but because such scientific research would take quite three crop seasons, and some measure of control was too urgently needed for time to be spent on such preliminary scientific proof. Having once started parasite liberations all over the Island, a large series of controlled experiments became impossible.

Moreover the writer considers that the fact that infestation of various pests can be reduced by limited experimental colonisations with *Trichogramma* has been proved by various workers in several countries during the past few years, and that this point is less in question than the possibility of large scale operations with *Trichogramma* as an economic pest control measure.

Further evidence is certainly needed as to the *numbers* of parasites required per unit area, particularly as statements such as the need to liberate a million parasites a *day* in a *small* area have appeared in print (43). In the present work a minimum of 2,100 parasites per acre are evenly distributed at each liberation. The question of numbers necessary for a unit area such as an acre depends on the nature and extent of the crop to be protected, of the insect infesting it, and of climatic conditions. Topography and the presence and extent of other crops would also have to be considered and the correct timing of liberations observed.

It is realised that the liberations in Barbados are at present not as adequate as is desired, but the method and nature of liberation are considered sufficient and suitable inasmuch as at the rate of one slip of about 170 parasitised eggs to every 10th cane stool, chessboard fashion the spheres of action of each colony should overlap in the first field generation; increased output would be used to make more frequent (or continuous) and more evenly distributed liberations. It is claimed that results justifying expansion to at least twice the present output have been obtained in spite of climatic and technical setbacks; and that by gradual elimination of setbacks in technique, a definite and an economic control over *Diatraea saccharalis* will be established in Barbados.

Breeding Technique.

The details of mass breeding *Trichogramma minutum* are best illustrated by plates XII—XXI.

Plate XII shows one of the 4 moth breeding units. Each one now holds 3,500 lb. of corn, in 90 horizontal trays in a large central rack; (during the first two mass breeding seasons, only 3,000 lb. of corn were placed in each unit). There is ample room inside for moving around, collecting moths by vacuum and

supervising trays for pest control. The units are ant proof, capable of being sealed for fumigation, and are reasonably pest proof, save by the entrance door, which is safeguarded as far as possible by the antechamber shown. The latest mechanical devices mentioned by Flanders (21) for collecting moths are not employed as the economic necessity for them is not apparent in Barbados, and the yield of moths and parasites obtained by existing methods compares very favourably with any other published accounts.

The pipes carrying vacuum from a central engine are seen entering the side of the unit and antechamber.

All units built in the future will be provided with ventilating cowls in the roof. At present all units are equipped wth electric fans inside, but this year, it has been necessary to spray the roofs several times daily with water in order to keep the temperature below 90°F.

Plate XIII. shows the apparatus for collecting moths. The stout hose is fixed onto a nozzle of the vacuum piping inside. A collecting cylinder is shown partially slid into the metal container, in which it rests on a cotton wool pad. A lid, through which passes the end of the tube, which, with its cork fits into the mouth of the container, is shown detached. The normal gauze lid of the collecting cylinder is shown at the side. Moths are sucked by regulated vacuum through the metal tube into the collecting cylinder, and when 200 – 250 moths are in the cylinder, the collecting tube and cap are removed, and the gauze lid fitted on whilst the vacuum holds the moths in the cylinder. A fresh cylinder is then inserted, and by this means the moths are rapidly collected in an undamaged condition into the receptacles in which they lay their eggs. The cylinders of moths are then placed in a separate room on sheets of paper on ant proof tables, (Plate XVI) and the moths deposit their eggs overnight between the gauze caps and the paper sheets. Various innovations employed by other writers for increasing egg production have been tried, but results so far have not justified a change from the method described.

Plate XIV shows four cylinders with eggs adhering to centre and sides of the gauze lids.

Plate XV shows a sheet of paper on which eight tins have rested showing the masses of eggs deposited on the paper as well as on the gauze of the lids.

These eggs are cleaned of moth scales and debris, and are brushed off into clean glass containers.

Plate XVI shows over 120 tins on their sheets of paper ready for egg deposition. Sometimes tins are retained for three nights and three layings obtained from the moths. Usually the majority are only retained two days, and when discarded, all moths living and dead are placed in a specially built receptacle of corn, so that any larvae which hatch from eggs so obtained will not be lost, but are eventually received, much multiplied, via the moth units.

Plate XVII. These sheets were devised by the writer as being the most convenient for breeding work and distribution. Two of them fit exactly into a glass tube 6 inches by 1 inch. They are cut and printed in bulk; and workers soon become adept at applying patches of gum arabic evenly in each section, onto which the *Sitotroga* eggs are dusted, the surplus shaken off, and the sheets allowed to dry. The eggs on the sheet on the left in Plate XVII are unparasitised; those on the right hand sheet are parasitised. To obtain a parasitism as depicted, two parasitised sections, as shown on the extreme left are required. This gives a *routine eight fold reproduction*. Very often only three sections are placed in a tube with two sheets of eggs, thus giving a ten-fold reproduction. At the end of the day's work, any surplus or swept up eggs, or those obtained by cleaning the insides of the tins, are returned to the moth units.

Plate XVIII shows an array of gauze capped tubes, each containing 4 sections of parasitised eggs. These sections are placed in the tubes 24 hours before the sheets of eggs are inserted. The parasites thus emerge several hours before the sheets are put in, and mating of parasites before oviposition is thus assured. The sheets are easily inserted without damaging or losing any parasites, by keeping the closed end of the tube towards a strong light, and tapping the tube sharply as each sheet is inserted.

Plate XIX shows rows of tubes (jars as shown, holding 3 sheets are occasionally used) both on the working bench and on the rack above in an ant proof parasite breeding room. Lighting is arranged so that an even, diffuse light is

obtained; very bright light from any direction is avoided, and under the conditions mentioned a very even parasitism is obtained. A full 100% parasitism of eggs can never be obtained, so on the 4th and 5th day, when *Sitotroga* larvae are due to hatch out from unparasitised eggs, the tubes are either placed in a tray of corn as shown, or else in the trays in the moth units, so that these larvae are not lost, but are returned as with all other potential moth producing material, into the breeding units.

On the 6th to 7th day, 24 hours before the parasites are due to hatch, the sheets are cut up into sections and the sections placed in cigarette tins as shown (Plate XX). In each tin 192 sections are placed, which will give an estimated yield of twenty-five to twenty-seven thousand parasites. These tins are then placed in cool storage at 40—45°F., and are distributed from thence to planters who are invited in by printed post cards to fetch and distribute the sections in their fields. Each section contains an average of 170 parasitised eggs, giving a minimum yield of 140 parasites per section. The *minimum* distribution per acre is therefore 2,100 parasites; original distributions, as made in 1929, were 750–800 per acre (58). It may be mentioned that the number of parasitised eggs per section is averaged each week for a large number of sections, to ensure that the sheets are properly made up, and above all, that the number of parasitised eggs per sheet keeps constant. A number of sections are also placed in separate small tubes, and the parasites hatching out are counted and the percentage hatch of parasites determined. In this way it is always known whether the rate of parasitism and percentage hatch of parasites is remaining normal, and from the figures obtained, weekly computations of the parasites bred and liberated are easily made, from the standardised sheets. The average number of parasitised eggs obtained per section is 170, and the average hatch of parasites is 84%. The number of eggs per section naturally varies somewhat, but the average for a large number remains fairly constant at the figure given. The percentage hatch of parasites rises as high as 90% but never falls below 80% and it speaks well for the ease with which this parasite can be mass handled that this steady output can be maintained as a routine procedure over several months. When computing the number of parasites reared, the percentage hatch is taken as 80, though as stated the average is higher; any figures given therefore are not overestimated.

Should any considerable variation occur in the number of parasitised eggs per section, or in the percentage hatch, the reason is at once sought out. Given steadiness in the gumming and preparation of the sheets, the only factors causing any variation in the above routine have been lack of scrupulous cleanliness in the glass breeding tubes, and excessive heat in the parasite room. The first point is a matter of organisation and supervision; the second however is more serious, and if the temperature in the parasite breeding room rises to above 90°F., there is usually a wholesale mortality of parasites and a resultant poor parasitism of eggs on the sheets. Already this season excessive heat has given trouble, and then, on adapting a cooler room to meet the need, incorrect lighting of the tubes resulted in diminished parasitism until remedied. After that, routine production became normal once more.

Plate XXI. shows the method of distribution of egg slips in the field; parasites are due to hatch within a few hours of being placed as shown and the risk from ants or other predators is not considered serious during the short period before the parasites hatch in the field.

Hindrances to Mass Breeding Trichogramma.

In addition to those already mentioned, namely the need for adequate cleanliness, temperature, and lighting, a series of pests can invade the moth breeding rooms and so reduce output or entirely stop all operations. These hindrances have been detailed in (59). It was attempted to overcome them in 1930 by sterilising all the corn by passing it through a Simons Heater. This unfortunately reduced the moisture content of the corn below the optimum for *Sitotroga* breeding with the result that fewer and smaller moths, and therefore less eggs were obtained; the situation was further aggravated by the heat and drought which prevailed throughout the season. This year, the corn was fumigated *in situ* with hydrocyanic acid after chemical analysis and biological tests had shown that the procedure was safe from the point of

PLATE XII.

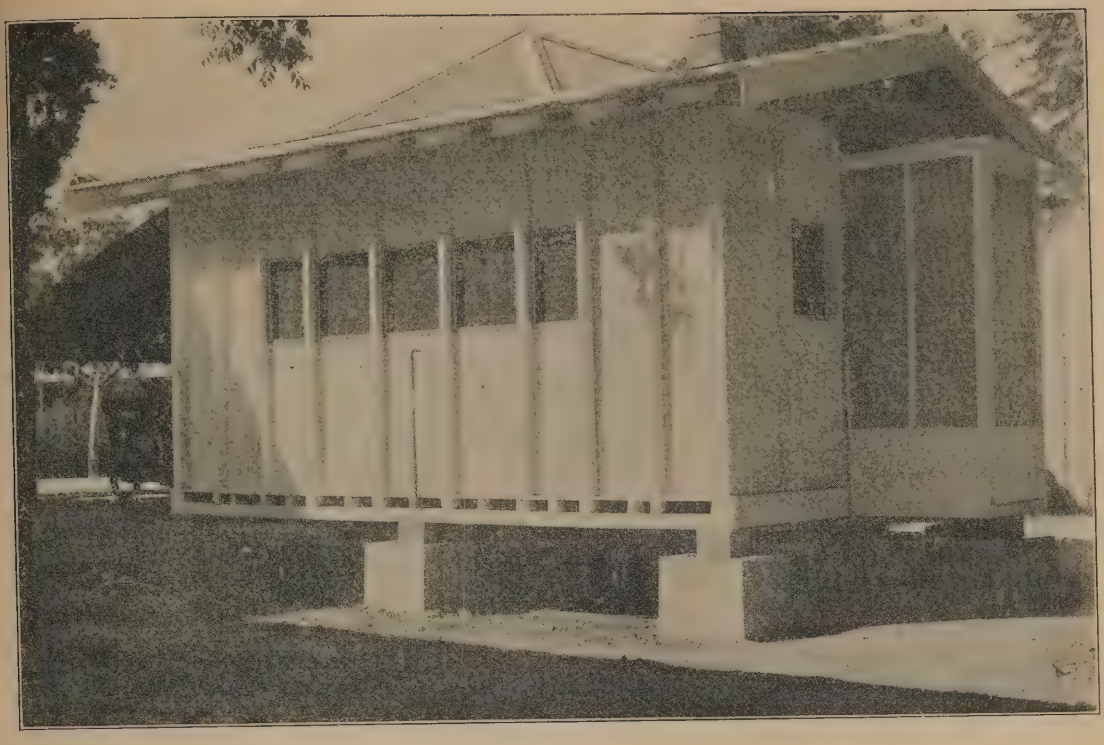

PLATE XIII.

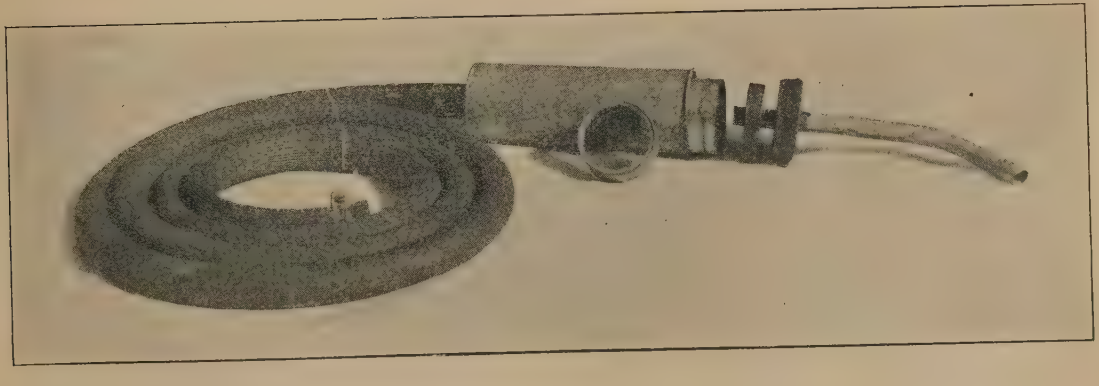

PLATE XIV.

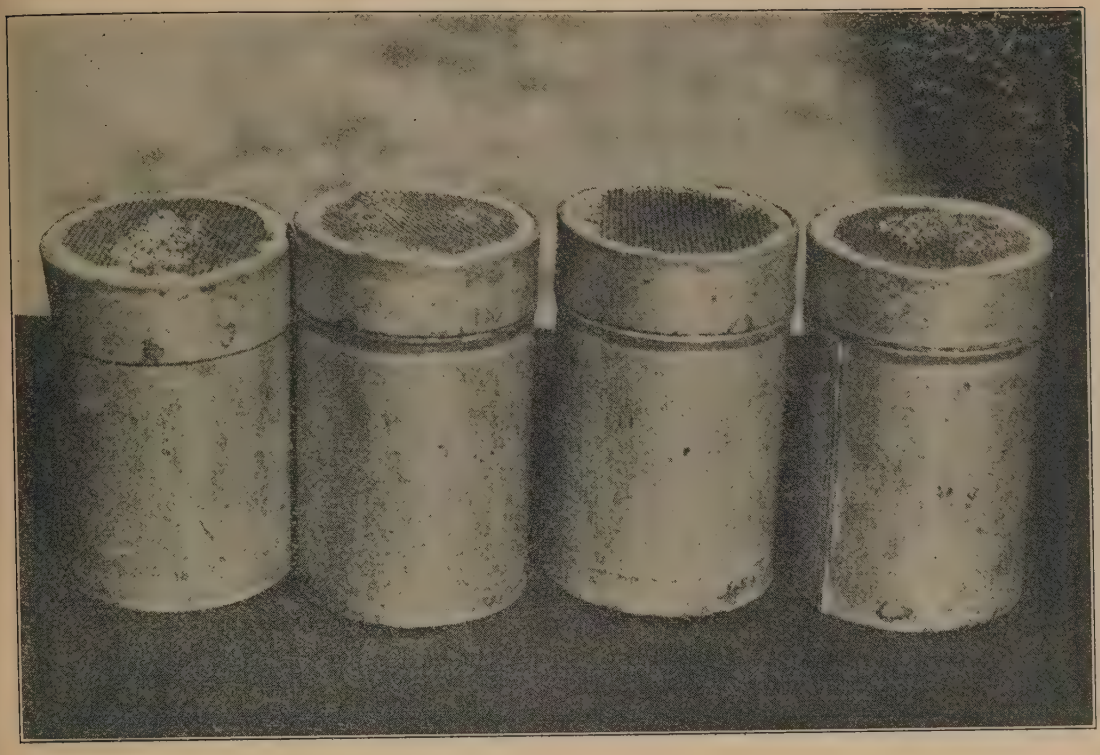

PLATE XV.

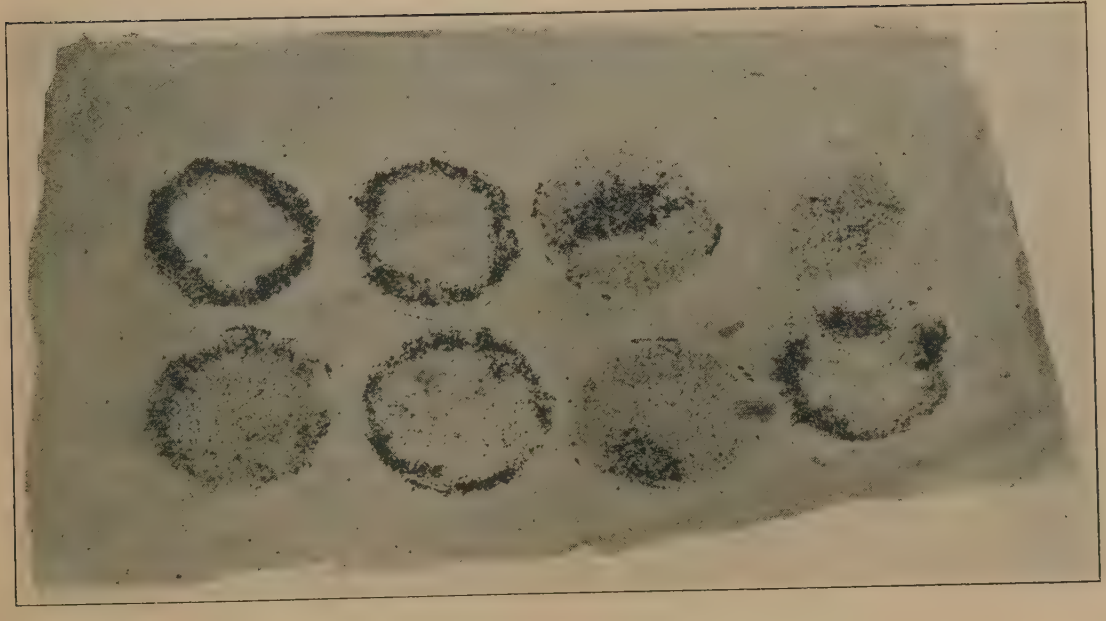

PLATE XVI.

PLATE XVII.

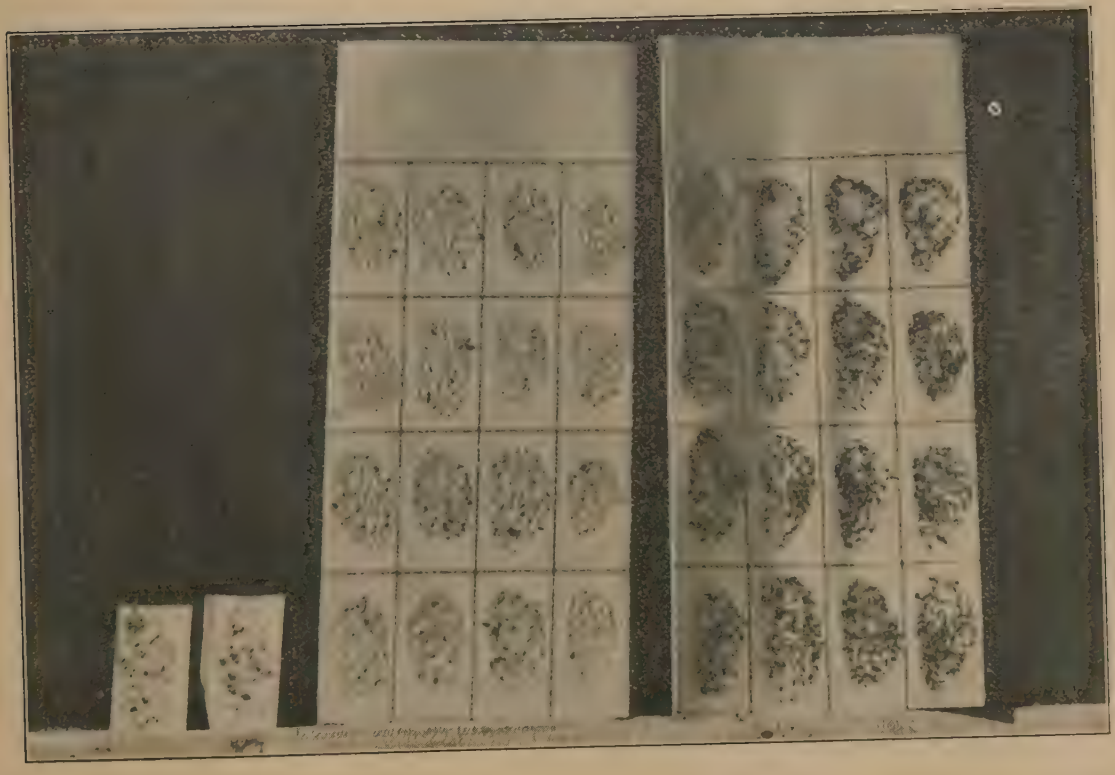

PLATE XVIII.

PLATE XIX.

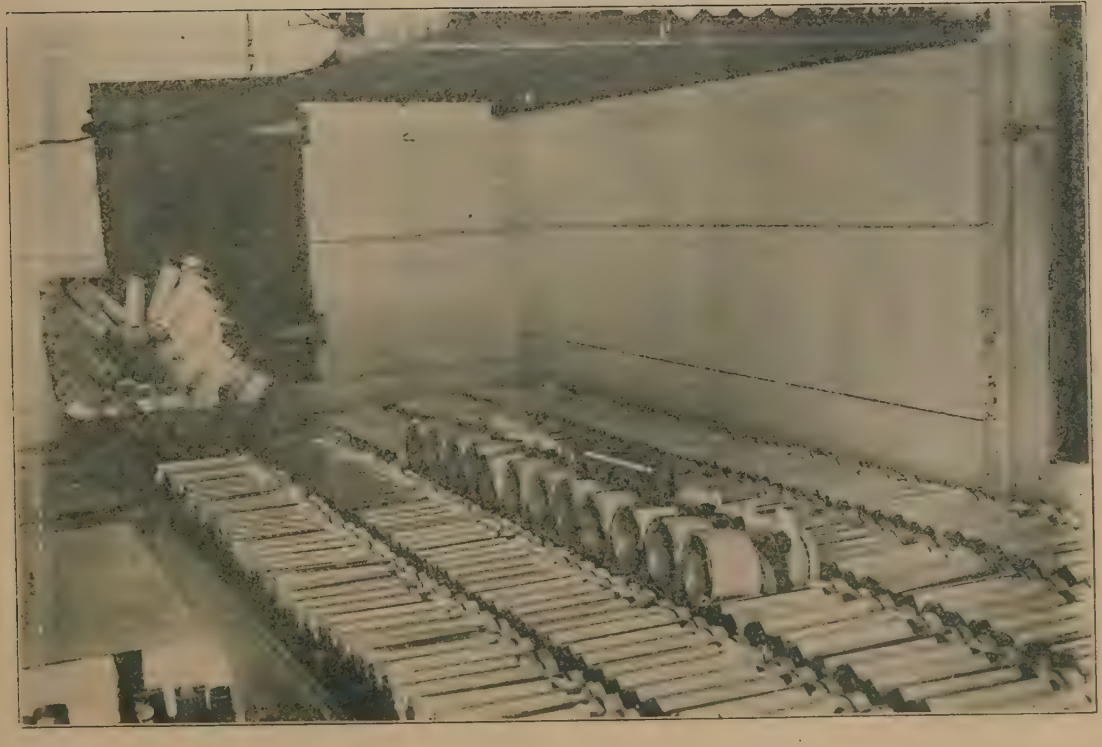

PLATE XX.

PLATE XXI.

Sitotroga breeding. As a result the units have remained exceptionally clear of parasites and pests this season and promise to remain so, with the exception of one unit badly infested with the rust red flour beetle *Tribolium ferrugineum*. This unit now gives the lowest production of moths, and it has been established by Alden and Farlinger (2) and confirmed by the writer, that these beetles feed on *Sitotroga* eggs and dead adult moths. This naturally constitutes then a serious hindrance to mass breeding work, and they are unfortunately the first to appear, are rapid breeders, and very difficult to eradicate.

The use of borax as advocated by Schwardt (51) against grain weevils was tried in a cage experiment, but with unsatisfactory results.

The pest is however being kept under by taking advantage of its habit of congregating in masses in confined, dark places. Boards are laid on the floor as traps, and from these and all hiding places such as between trays and racks, under trays, covers, etc., many thousands of beetles are crushed or swept daily into tins containing oil emulsion; the floor is also washed down with hot carbolic solution from time to time.

No trouble at all is now experienced from mites, and it is found that 5 lb. of sulphur dust to the 3,500 lb. of corn per unit is quite sufficient to control all mites, and yet not to interfere at all with *Diatraea* or the subsequent work of *Trichogramma*. (1).

Numbers reared and Distributed.

In 1929 a total of 22,816,700 parasites were liberated (numbers liberated represent 7/8 of the total number bred, the remaining 1/8 being absorbed as breeding stock). In 1930 liberations amounted to 36,930,000, which with an additional 2,160,000 liberated in January and February 1931, makes a total of 38,090,000 parasites liberated or a total of over 43,500,000 bred up, from 12,000 lb. of corn. Flanders (17) records 30,000,000 parasites available for liberation for breeding which 25,500 lbs. of corn were used. Hinds and Spencer (29) record 10,000,000 parasites from 100 bushels or about 7,000 lb. of corn.

During the present season of 1931, 14,000 lb. of corn are being used in the breeding rooms, but it is realised that even so the production of parasites will not be entirely adequate.

With double the amount of equipment, it would be possible to maintain a steady output of parasites with constant distributions throughout the young canes from January onwards, and much larger and more frequent distributions during the critical months of June to September. After October, Planters are not so willing to distribute parasites throughout the fields on account of the difficulty in penetrating through the fields. By then, moreover, parasitism should have been established everywhere to a point at which numbers artificially added would make no appreciable difference; though if available there is no reason why they should not be distributed in the head rows of cane fields.

Cost of Mass Production of Trichogramma.

As stated, a total of 43,500,000 parasites were bred, and 38,090,000 liberated during a period of 12 months and it is considered by the writer that more should have been obtained. To obtain these numbers equipment to the value of £550 was employed, and £100 worth of corn was used. The equipment will last for a long period of years, but counting its life at 5 years only, a capital expenditure of £110 per annum can be entered. Other expenses including all salaries, overtime, painting and repairs to units, renewals of equipment, refrigeration and electricity, amount to £1,120 a year. The total expenditure per annum therefore is £1,330 for which protection is given to 35,000* acres of growing cane annually. This amounts to 9.12d. per acre per annum, or, excluding salaries and counting capital and working costs of £380 per annum, the amount is 2.6d. per acre. If the latter figures were doubled it would still be an exceedingly cheap protection for a crop valued at £17 per acre even in the present severely depressed times.

* Report of West Indian Sugar Commission in 1930.

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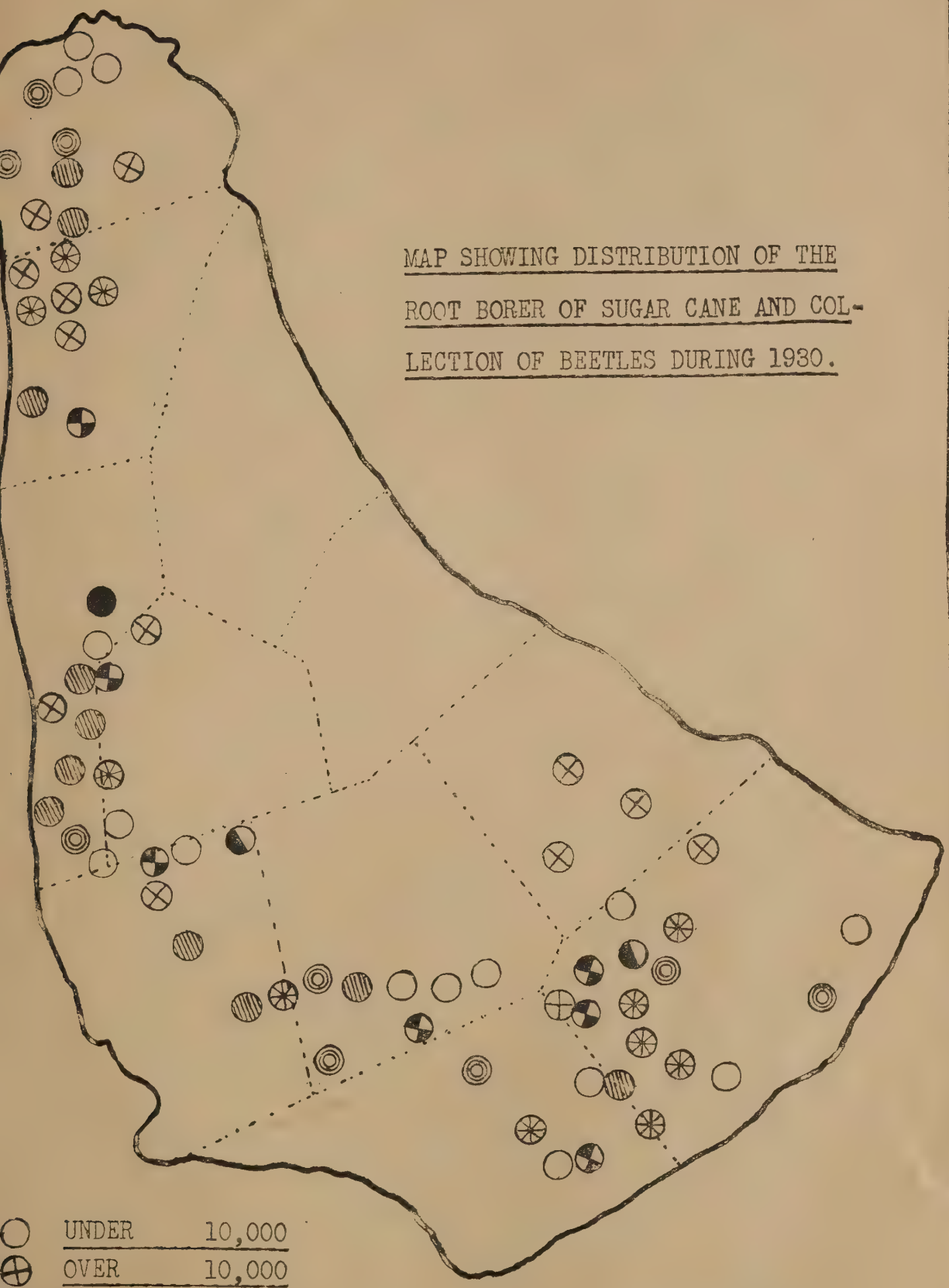
SECTION III. CONTROL OF CANE ROOT BORER.

(*Diaprepes abbreviatus*, Linn.).

The control measures against *Diaprepes* which were outlined in last year's report are being steadily incorporated into routine plantation practice, though the cultural methods of ploughing instead of forking fields, and of splitting or destroying cane stumps could still be more widely practised. The collection of beetles during the year under review was satisfactory, a total of 6½ millions being accounted for, in spite of the dryness of the year. A very large number of egg masses were also collected and destroyed, and of these eighteen thousand eggs were examined for evidence of parasitism. No parasitism was found, and but very slight natural mortality of eggs due to invasion by fungus or by some predator; the proportion thus damaged was insignificant. There is therefore no known natural check on this pest save for toads and lizards, etc. and birds. It is intended to import the egg parasite *Tetrastichus haitensis* which, it is hoped, will be obtained in Haiti by Dr. J. G. Myers, in order to establish if possible a natural check on the pest.

The results of systematic collection of beetles throughout the entire year, together with proper cultural practices have been well demonstrated on Lancaster Plantation in the Parish of St. James. A few years ago *Diaprepes* was

MAP SHOWING DISTRIBUTION OF THE ROOT BORER OF SUGAR CANE AND COLLECTION OF BEETLES DURING 1930.



UNDER	10,000
OVER	10,000
"	30,000
"	60,000
"	100,000
"	200,000
"	700,000
"	1,000,000

very prevalent on this estate, even to the extent of preventing the growing of cane at all in some fields, and making even first ratooning unprofitable on most of the estate. After two years of continuous control measures, beetles being collected during *every* month of the year, cane can now be grown in every field, first ratoon tonnages have increased remarkably, and second ratoon crops are now possible. Other estates have also carried out very successful campaigns against *Diaprepes,* but on the estate mentioned the Manager, Mr. B. H. V. Outram has provided exact records of all expenditure in connection with the work, so that it is possible to measure the cost against the increased returns obtained from control. Altogether 1,315,200 root borer beetles were collected in twelve months at a cost of $770 (£160. 8. 4) and 277,000 brown hardbacks (*Phytalus smithi*) at a cost of $83 (£17.5.10). Collectors were paid at the rate of 40 cents per pint of beetles (800 to a pint), and the total cost per pint for *Diaprepes* including all charges, work out at 46.8 cents. This figure is much in excess of the average sum paid on other estates which ranges from 20 to 24 cents a pint, with overhead changes unknown. By paying a higher amount, workers were induced to pick beetles regularly, and to keep on the job every month. The following results show an increased return from 1st ratoons, which alone gave more than double the amount expended for the year.

Year	Plant crop average tonnage	1st Ratoons average tonnage	2nd Ratoons average tonnage	Rainfall during 18 months from planting to reaping	Beetles collected
1930 ..	34.89	18.06	Ratooning impossible	88.39 ins.	494,700 (in 1929)
1931 ..	30.21	25.47	22.27	64.00 ins.	1,315,200 (in 1930)

The drought condition which obtained during the growth of the 1931 crop, with a shortage of 24.39 inches of rain, would naturally result in a diminished tonnage, as is evident to a comparatively small extent in the plant crop tonnage. First ratoon crop tonnage however, instead of being still more reduced is increased to an extent which, on the average acreage concerned, doubly repaid all expenses even at the prevailing low price of canes; second ratoon crop instead of being impossible, as in former years, yielded profitable returns.

Apart from any increase due to partial control of moth borer, the increase on this estate can be ascribed to the past two or three years of intensive campaign against the root borer which has been efficiently carried out and recorded; no changes in plantation routine other than insect control are known which would account for the increased tonnages recorded.

The distribution of *Diaprepes abbreviatus* and its prevalence as evidenced by returns of numbers collected by Planters, is shown in Plate XXII. The areas infested are the coastal areas of low rainfall. The remaining hilly regions of higher rainfall are unaffected by the beetle, or if present, it does not attract economic notice. It would appear that the rainfall, or average moisture content of the soil is a limiting factor in the spread of this pest.

SECTION IV. CANE WEEVIL BORER.

(*Metamasius sericeus*: Oliv.)

This pest is serious apparently only in scattered localities. It is of course widely spread over the Island, but no field survey as to the intensity of its prevalence has been possible. It is essentially a pest of cut or damaged canes

and dozens of grubs, pupae, and newly emerged adults can be found in a single rotten cane. In factory yard examinations of cane it was seldom that *Metamasius* damage was seen and only on two occasions was extensive damage in the field reported. In one case a considerable number of canes in a mature late reaped field were affected. In the other case, cut cane stumps were riddled and the whole ratoon stool was often killed by fermentation or souring; it was ascertained that these fields had had a considerable number of damaged and rotten canes at reaping time, which had been left in the field, and were found *in situ* to have bred *Metamasius*. It is essential for the control of this pest that rotten or damaged cane should not be left in the field, and that stumps not intended for ratooning should be dug up and destroyed. These cultural practices are primarily recommended for control of *Diatraea* and *Diaprepes* and it is usually contended that control of *Metamasius* will follow control of the former pests.

SECTION V. PINK BOLLWORM.

(*Pectinophora gossypiella*, Saund.).

Details of the control measures adopted against this pest were given in last year's report and these measures have been in operation during the year under review. A considerable amount of cotton seed for milling was imported into the Island (eighteen schooners full) and the disinfection of seed by heat and fumigation of ships and bags with Zyklon B, has proceeded normally. A good crop of cotton was obtained, in spite of the severe drought; and regular field inspection of the plants and dissections of bolls were carried out to discover the presence, if any, of pink bollworm. It was not until late in the picking season that the pest was found (February, 1931) and then only in one or two localities and in such small numbers as to preclude any economic damage being caused. With the continued enforcement of regulations, particularly of field sanitation and close season, a satisfactory control over the pest should be maintained.

SECTION VI. ARMY WORMS AND DEFOLIATORS.

Army worms, *Xylomyges eridania*, in particular, and defoliators such as *Alabama argillacea* on cotton and the lesser cotton worm *Aletia luridula* were present in abnormal numbers in late December 1930 and in January 1931. In the latter month *Xylomyges* appeared, and invaded sweet potato fields. When on the march, this species devours numerous species of weeds on grasslands and road banks, and feeds even on grass and on cow pea bushes; when marching through a canefield it destroys practically every weed particularly convolvulaceae. A large number apparently pupate on the march, and later re-infest sweet potato and cotton fields in the neighbourhood. The main army which includes larvae of all ages and sizes invades potato or cotton fields, doing extensive damage.

In one case, in which valuable seedling varieties of potatoes had to be protected, the digging of trenches in the path of the army as well as repeated dusting of the plants with Paris green and lime were tried. Trench digging however has usually to be done by spade in Barbados instead of by plough, and is expensive, slow and unsatisfactory. Poison bait can seldom be used because bran is both expensive and difficult to obtain, and in the case of army worm invasion, the bait must be available immediately. The effective methods against this pest were found to be dusting with Paris green and lime in the proportion of 1 of Paris green to 6 or 8 of lime, and hand crushing the larvae. The latter may appear an expensive operation, but actually, when hundreds of larvae were to be found clustered under each potato vine, two or three workers armed with small besoms, or bundles of twigs, could, by lifting and shaking the vines and then beating the ground, kill very large numbers at a smaller cost than digging trenches or using poison bait. After the hand cleaning, which was only employed when a heavy invasion had taken place, the plants were dusted as often as necessary with Paris green. The result was a satisfactory control. Similarly in the case of *Alabama argillacea* on cotton, repeated dustings with poison as soon as the presence of defoliators was noticed, gave satisfactory control. Calcium arsenate and lead arsenate are used

as dusts in certain cases, but Paris green is usually recommended because its distinctive colour lessens the chances of errors or accidents with coloured labour, and also minimises aphis attraction to dusted cotton.

Arrangements have also been made to introduce the Tachinid *Compsilura concinnata* from America through the kind co-operation of the Gipsy Moth Laboratory, U.S. Department of Agriculture. If the introduction is successful, it is hoped that the parasite will attack and become esablished in some of the numerous Lepidopterous larvae which are pests in Barbados.

Dusting and Spraying.

The protection of crops such as sweet potato and cotton and the cleaning of fruit and ornamental trees from scale insects is essential in Barbados. Dusting is usually employed for field crops and of course spraying, for scale insects; both have usually been done in an inefficient, haphazard fashion, because adequate apparatus and sprays have not been available and correct spraying methods were not understood. Owing to high winds and frequent showers, however light, at the time that crop protection is needed, dusting must be carried out efficiently, without waste, and at suitable times in order to be economic. Various types of hand dusting machines have therefore been imported during the last year and their use demonstrated in order to supersede as far as possible the bag method usually employed, and so make crop protection more universal, efficient and economic.

Similarly, portable and hand spraying apparatus has been imported, and proper commerical oil sprays and insecticidal mixtures made available in the market in order to improve the spraying of trees. Experiments will also be made to ascertain whether spraying with light, easily handled one man sprayers can take the place of dusting in areas where high winds make the application of dusts troublesome. The difficulty of providing water for spraying field crops may prove less than the difficulty of maintaining protection by means of dust.

SECTION VII. SWEET POTATO WEEVIL.

(*Euscepes batatae*, Waterh.)

Newly hatched unfed beetles were kept in the laboratory without food or water for 45 days; generations of beetles were also bred in very small sections of potatoes in salve tins. Both experiments show the capabilities of the beetle of living and breeding under conditions harder than are ever likely to occur in the field, and emphasize its power of surviving to reinfest successive crops; for moisture is usually obtainable in the field, and it is as a rule impossible to remove all fragments of potato from a cropped field, however thoroughly it may be cleaned.

A certain amount of evidence has also been obtained showing that some varieties of potato are less susceptible to attack, and that the moisture content of the soil is a considerable factor in limiting the extent of, or even preventing attack.

Both these lines will be thoroughly investigated in the coming year together with the possibilities of cultural methods and the use of poisons and repellants.

Publications.

The following articles were published during the year.

Sugar Cane Borers—Trop. Agric. Vol. VII. No. 11 pp. 292—295.

Agricultural Notes—Dept. Science & Agriculture, Barbados, Pamphlet No. 6.

Control of Field, Crop, Garden and Fruit Pests in Barbados—Dept. Science & Agriculture, Barbados, Pamphlet No. 7.

REPORT OF PLANT DISEASES INSPECTOR FOR THE YEAR, 1930—31.

(D. R. WILES, D.I.C.T.A.)

SECTION I.—SUGAR CANE MOSAIC DISEASE.

The inspection of cane for the mosaic disease was continued throughout the island for the whole year until the cane fields became impassable; diseased stools being removed whenever found.

The Corn Close Season was again proclaimed for the infected areas mentioned in Departmental Reports for the years 1927–28, 1928—29, extending from the 16th December, 1930 to the 31st March, 1931. Due to the scarcity of fodder a great deal of difficulty was experienced in maintaining this Close Season as many occupiers did not regard the seriousness of the offence which led to their being prosecuted, thirty-three complaints being filed, the defendants being fined £1 and 1/- costs in each instance.

During the cane planting season extending from November, 1930, to March, 1931, healthy cane plants were distributed to occupiers of land in the proclaimed infected areas (*vide* Annual Reports, 1927-28, 1928-29), the centres of distribution being as follows:—

St. Michael	..	Lears Plantation.
St. James and St. Thomas	..	RidgewayPantation.
St. Peter	..	Alleynedale Plantation.
Christ Church	..	Frere Pilgrim Plantation.

Plants were distributed under the supervision of an Inspector.

Many occupiers in the proclaimed infected areas were allowed to obtain their plants from their own plots after these had been inspected by an Officer of the Department, Certificates of Approval being issued in the usual manner.

The inspection of the young crop commenced in mid-January, 1931, and is being continued until the fields become impassable.

Parish of St. Michael.

The mosaic infection in this parish is confined to certain tenantries and small holdings which are within the infected area. It will be noted that from the subjoined table 5,336 acres were inspected and 5,867 diseased holes found, certain areas being inspected twice or three times. Many of the occupiers were able to obtain their plants from their own holdings after these had been inspected by an Officer of the Department, and it is with pleasure that I have to report that there were again no diseased holes found in the Belle Tenantry or Welches although these areas were allowed to cut their own plants.

Parish of Christ Church.

The terrific drought which this parish experienced during the early part of 1931 has considerably lessened the acreage in cane in the infected areas and the majority of diseased holes observed were scattered throughout the parish.

Parish of St. Philip.

The acreage inspected in this parish is small when compared with the other parishes, this being due to inspections being curtailed as during the latter part of last year no diseased holes were found.

Parish of St. John.

Systematic inspections of estates and tenantries were commenced in this parish this year and it was found that there was a fairly heavy mosaic infection on certain estates; the diseased holes found have been removed under the supervision of the Inspector by labour provided by the Management and it is hoped that next year the infection will be considerably less.

Parish of St. Joseph.

The infection in this parish is confined to the tenantries of Sugar Hill and Chimborazo and it is expected that by careful selection of plants during the planting season under the supervision of an Inspector beneficial results will be obtained.

Parish of St. Lucy.

The Infected Area in this parish, Checker Hall Tenantry, was removed, from the list of proclaimed infected areas in 1930 due to the non-presence of any diseased holes for the past two years. During the planting season an Inspector supervised the cutting of the plants from the occupiers' plots thereby ensuring that no diseased plants were used. The mosaic infection in this parish was found for the first time in the eastern portion and all diseased holes were immediately removed and destroyed.

Parish of St. Peter.

The drought during the early part of 1931 affected the growth of the young crop in the infected area in this parish and many of the plots were destroyed for the abovemetioned reason. The crop which still remains in the infected area is entriely free from infection up to the time of writing. The diseased holes found in this parish were observed in several fields on large estates.

Parish of St. James.

The infection in certain of the proclaimed infected areas continues to be on the decline while in other districts it has remained fairly constant. It is, however, anticipated that it will be much less next year as a consequence of the constant inspection and rogueing of diseased stools. Certain areas were removed from the list of infected areas during the year and for the period under review no infection has been observed in these areas.

Parish of St. Thomas.

The supply of healthy plants to Rock Hall Tenantry and the surrounding neighbourhood had made a considerable difference in the number of infected holes found, the infection being principally confined to ratoons. The mosaic infection in this parish appears to have spread as infected stools were observed on estates for the first time this year.

Parish of St. George.

Inspections in this parish were commenced on a much larger scale than heretofore and it has been observed that in certain large tenantries the infection is fairly high. The infection in the infected areas has lessened considerably due, no doubt, to the proper selection of healthy plants by an Officer of the Department at planting time.

The systematic inspection and rogueing of infected stools cannot be too strongly recommended and managers, owners and occupiers should not await the arrival of an officer of the Department but should remove any infected stool whenever found.

Careful selection of healthy plants should be made at the time of planting so as to ensure that no infected canes are used for plants otherwise it will be found that the young crop will show signs of heavy mosaic infection at a very early stage of its development. Provided sufficient notice is given, plots from which managers and occupiers desire to obtain their plants are examined by an officer of the Department thereby ensuring that only healthy canes are being used as planting material. During the year many availed themselves of this service and it is hoped that in the near future this inspection will be practically universal.

The co-operation between the officers of the Department and the owners of small holdings has been of a very cordial nature in that there were no prosecutions instituted against any occupier for not removing diseased holes.

Appended is a comparative table showing the mosaic infection of young canes for the years 1928, 1929 and 1930.

Parish.	1928.		1929.		1930.	
	Acreage Inspected.	No. of Infected Holes.	Acreage Inspected.	No. of Infected Holes.	Acreage Inspected.	No. of Infected Holes.
St. Michael ..	2,184	15,343	3,812	5,221	5,336¾	5,867
Christ Church	3,064	2,133	3,398¼	452	3,790¼	264
St. Philip ..	1,789½	115	2,173¾	3	771¾	0
St. Lucy ..	617¼	229	692	56	1,922¼	162
St. Peter ..	1,762¼	5,724	2,568¼	782	2,676½	81
St. James ..	454¼	793	960½	846	1,275½	1,267
St. Thomas ..	947	3,490	905¼	1,626	1,755	692
St. Joseph ..	79	2	383	111	179¼	231
St. George ..	..	..	433½	1,559	1,178¾	2,759
St. John ..	108	..	7	..	1,060¾	2,304
St. Andrew ..	..	..	..	..	..	..
Total ..	11,005¼	27,829	15,333½	10,656	19,946¾	13,627
Ratio of infected holes per 100 acres infected		100: 252		100: 69		100: 68

From the above it will be seen that the number of infected holes found in 1930 still remains high; this is accounted for as follows:—

(1) A larger number of acres have been inspected this year, this number also includes certain areas which had to be inspected twice or three times due to being very heavily infected with the disease.

(2) Certain areas, especially in the parishes of St. George and St. John, where proper care had not been taken in the selection of healthy plants have become very heavily infected with the disease.

SECTION II—GUMMING DISEASE OF SUGAR CANE.

The leaf symptoms of the gumming disease of the sugar cane have again continued to make their appearance in certain parishes of the island but up to the time of writing no gummy exudation from the cut ends of the cane has been observed.

The variety of cane which appears to be the most susceptible to this disease is the Ba.11569 and in certain districts this variety has been replaced by the following, B.374, B.417 and B.891 which were observed last year to show considerable resistance.

B.374 and B.891 cane plants were distributed to the proclaimed infected Areas under the Mosaic Disease Eradication Act in the Infected Areas in the parishes of St. Peter, St. James and St. Thomas thereby assisting in controlling both the mosaic disease and the gumming disease.

Sugar factories in the parishes which are heavily infected with the gumming disease report that they had very little trouble in the manufacture of sugar provided proper attention was paid to the clarification of the juice; this is one of the most conclusive proofs that the gumming present in Barbados has not reached a very dangerous stage.

Care should be taken to prevent the increase of the disease by the careful selection of plants at planting time and by planting varieties which are fairly resistant to the disease.

SECTION III—INSPECTIONS UNDER THE COTTON DISEASES PREVENTION ACT 1928.

Cotton was planted universally throughout the island for the first time for many years and due to the late period adopted for planting a Pamphlet was issued by the Department advocating closer spacing. This method was adopted to a large extent and the benefits derived from this recommendation were observed especially in the parishes of St. Philip and St. Lucy. The total acreage planted in 1930—31 was 2,845 from which 616 bales of lint were obtained.

A Peasant Cotton Plot Competition was held and prizes were offered for the best plot planted in accordance with the instructions outlined in the Departmental Pamphlet. Entries were received from all parts of the island and the prizes were distributed at the Local Show held at Lemon Arbor in St. John. The 1st prize was awarded to a plot in the parish of St. Lucy.

Constant inspections of the cotton plots were made throughout the growing season so as to discover the time the pink bollworm would attack the bolls. From the 15th January to the 15th March, 1931, 6,981 bolls were collected from all parts of the island and examined for the presence of pink bollworm but none were found. In the middle of February, however, the pink bollworm was discovered in St. Michael and at the end of April in St. George. On account of this discovery the close season for 1931 was fixed extending from 1st May to the 31st August throughout the island, with the exception of certain areas in St. Lucy and St. Philip when the close season ends on the 15th August.

The inspection of tenantries during the present close season is being carried out and in one instance pink bollworm has been found in the bolls of one of these wild cotton trees; these trees are being destroyed by fire as soon as they are found.

The cleaning up of the cotton plots which were planted in 1930 was supervised by Officers of the Department and it is pleasing to record the hearty co-operation which officers received from the managements concerned who tried to carry out the instructions of the Inspectors in the best possible manner. The plots which were planted by peasants have been effectually destroyed and no difficulty was experienced with the growers concerned.

An okra close season extending from the 15th April to the 15th May, 1931, was again proclaimed, and as in previous years permission was granted to occupiers to keep their okras for vegetable purposes only. Under this section there was only one prosecution, the defendant being fined £1.

Prosecutions were instituted against two estates and one small grower who did not effectively clean up their cotton plots. Four persons were also prosecuted who had removed cotton bushes from the field in which the cotton had been grown and for having them stored up on their premises during the close season.

During the period under review 21,874 bags of imported cotton seed were disinfected by means of the Simon's Heater under the supervision of an Inspector and 17 ships fumigated with Zyklon B.

SECTION IV.—MISCELLANEOUS INSPECTIONS.

For the period under review the following privately imported plants were examined:—

	How Disposed of.
933 packages of Bulbs, Rose trees, Carnation plants, Vegetable and Flower Garden Seeds	Examined and passed.
12 Nutmeg plants	All soil removed and roots washed.
4 Palms	do. do. do.
50 Mango plants	do. do. do.
22 Citrus plants	do. do. do.
2 Cocoa plants	do. do. do.
1 box Guava plants	do. do. do.
1 „ Pepper plants	do. do. do.
1 „ Croton cuttings	Examined and passed.
6 „ Orchids	do. do.
2 „ Pineapple suckers	do. do.
2 packages Cane cuttings	Destroyed.

APPENDIX I.

METEOROLOGICAL OBSERVATIONS.

RECORDED AT THE METEOROLOGICAL STATION, CODRINGTON.

Height Above Sea-Level, 181 feet.

Latitude 13°7′ 36″N. *Longitude 59°35′ 57″W.*

The following are summaries of the observations recorded for the year 1930. The details are given in Appendix II.

Barometric Pressure.—The records refer to observations made at the hours of 9 a.m. and 3 p.m. only and are expressed in inches of mercury. During the year 1930 the mean pressure corrected for temperature and gravity and reduced to sea-level was at 9 a.m. 29.987 and at 3 p.m. 29.909, the highest pressure recorded being 30.103 at 9 a.m. on May 20th and the lowest 29.776 at 3 p.m. on August 17th. For the ten-year period 1920—29 the average barometric pressure was at 9 a.m. 29.977 and at 3 p.m. 29·902. The highest pressure recorded at 9 a.m. during the ten-year period was 30.127 inches on January 22, 1925, and the lowest pressure recorded at 3 p.m. was 29.694 inches on September 8, 1921.

Temperature.—The daily mean maximum temperature for the year 1930 was 85.2°F. and the daily mean minimum 72.0°F. The maximum extreme for the year was 91.4°F. registered on August 30th and the minimum was 65.6°F. registered on April 11th. The average daily mean temperature was 78·6°F., the highest monthly range 22.6°F., and the lowest 17.0°F., the mean monthly range being 18.7°F. For the ten-year period 1920-29 the daily mean maximum temperature was 85.2°F., and the daily mean minimum 72.8°. During the ten-year period the average daily mean temperature was 79.0°F., the maximum extreme was 91.5°F. on August 23rd, 1927, the minimum extreme 63.2°F. on March 24th, 1925, and the average monthly range 18.3°F.

Tension of Vapour and Relative Humidity.—The mean tension of vapour for the year 1930 was at 8 a.m. .725 and at 5 p.m. .705. The mean relative humidity was at 8 a.m. 69.9% and at 5 p.m. 67.7%.

Wind.—The daily (24-hour period) mean velocity of the wind during the year 1930 was 10.0 miles an hour. Records were kept of half daily or 12 hour periods from 6 a.m. to 6 p.m. and 6 p.m. to 6 a.m. The maximum velocity for any such 12-hour period was 22.0 miles an hour, recorded between 6 a.m. and 6 p.m. on July 3rd and the minimum velocity was 1.5 miles an hour, recorded between 6 p.m. and 6 a.m. on August 24th and 31st.

Rainfall.—The rainfall measured at the Government Meteorological Station during the year 1930 amounted to 29.40 inches. Rainfall was recorded on 166 days, the greatest fall being 2.16 inches on September 29th. For the ten-year period 1920—29 the average rainfall was 43.88 inches and the average number of days annually on which rain fell was 179.

Rainfall of the Island.—The total mean rainfall for the year 1930 from 172 stations was 38.44 inches, being 22.42 inches below the average for the sixty years ended December 31, 1929, which was 60.86 inches. The 1930 rainfall was the lowest annual total recorded.

PLATE 23

DIAGRAM ILLUSTRATING ISLAND'S

AVERAGE ANNUAL RAINFALL

FROM 1890 - 1929.

41 - 50 INS.

51 - 60 INS.

61 - 70 INS.

71 - 80 INS.

APPENDIX II.

METEOROLOGICAL REPORT FOR 1930.

DEPARTMENT OF AGRICULTURE, BARBADOS

Height above Sea Level 181 *Feet.*

Months.	Barometric Pressure reduced to 32° Fahrenheit, Latitude 13° 7′ N., Mean Sea-level, and corrected for gravity.					Temperature °F.								Tension of Vapour			Relative Humidity.			Wind		
	9 a.m.	3 p.m.	Mean.	Highest.	Lowest.	Max. Mean.	Min. Mean.	Max. Extreme.	Min. Extreme.	Mean for Month.	Range for Month	Dew Point 8 a.m.	Dew Point 5 p.m.	8 a.m.	5 p.m.	Mean.	8 a.m.	5 p.m.	Mean.	Velocity, miles per hour.	Rainfall.	No. of days on which rain fell.
January ...	30·021	29·936	29·978	30·086	29·835	82·6	70·7	84·1	67·4	76·7	17·0	67·2	67·1	·671	·664	·668	72·7	72·6	72·7	12·0	2·28	21
February ...	30·021	29·933	29·977	30·081	29·819	82·9	69·5	84·6	66·0	76·2	18·6	65·9	64·1	·645	·605	·625	71·9	64·1	68·0	10·6	·88	11
March	30·011	29·928	29·969	30·081	29·856	85·0	70·2	87·6	66·8	77·6	20·8	65·9	65·4	·638	·626	·632	65·6	62·2	63·9	10·4	·14	2
April	30·000	29·919	29·959	30·060	29·868	85·6	71·1	88·2	65·6	78·5	22·6	67·8	66·5	·677	·652	·664	67·4	64·7	66·0	12·6	1·07	8
May	30·022	29·945	29·984	30·103	29·871	87·7	73·6	89·2	70·8	80·7	18·4	69·1	68·5	·710	·696	·703	65·0	64·9	64·9	12·0	·67	7
June	29·995	29·929	29·962	30·067	29·889	86·2	73·8	89·2	69·8	80·0	19·4	70·6	69·1	·752	·720	·736	70·4	67·5	68·9	12·1	4·00	19
July	29·995	29·931	29·963	30·068	29·851	85·8	73·5	88·2	69·8	79·7	18·4	70·7	69·9	·751	·733	·742	70·2	67·7	68·9	12·4	3·76	19
August	29·984	29·911	29·948	30·076	29·776	87·8	73·6	91·4	70·4	80·7	21·0	72·2	71·4	·795	·769	·782	71·6	68·9	70·3	7·4	2·41	18
September ..	29·963	29·898	29·931	30·013	29·835	87·4	73·1	90·6	70·2	80·3	20·4	70·6	71·1	·753	·763	758	66·6	67·9	67·3	7·0	4·59	19
October ..	29·936	29·859	29·898	30·001	29·814	85·0	72·6	88·2	68·8	78·8	19·4	71·8	71·2	·780	·763	·772	70·9	71·2	71·1	6·5	4·18	16
November ...	29·941	29·850	29·895	30·027	29·790	84·1	71·4	88·5	68·5	77·8	20·0	71·3	70·4	·769	·749	·759	71·2	70·8	71·0	6·7	3·33	13
December ...	29·953	29·859	29·911	30·028	29·803	82·6	70·7	86·5	68·0	76·7	18·5	70·8	69·6	·755	·729	742	73·2	70·5	72·8	9·8	2·09	13
Total ...	359·812	358·908	359·375	360·691	358·031	1022·7	864·1	1056·6	822·1	943·7	234·5	833·9	824·9	8·696	8·469	8·583	838·7	813·0	825·9	119·5	29·40	166
Average ...	29·987	29·909	29·948	30·057	29·836	85·2	72·0	88·0	68·5	78·6	18·7	68·7	68·8	·725	·705	·715	69·9	67·7	68·8	10·0		

RAINFALL AT SUGAR CANE EXPERIMENT STATIONS FROM DECEMBER 1929 TO MARCH 1931.

Station.	Height above Sea-level in feet.	December 1929.		January 1930.		February.		March.		April.		May.		June.		July.		August.		September.		October.		November.		December.		January. 1931.		February.		March.		Total.	
		Days.	Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.	Days.	Inches.
Coverley	254	17	3·15	16	3·06	4	·50	3	·69	10	2·05	5	·30	10	3·79	13	3·11	15	2·60	9	2·51	11	2·63	10	1·98	10	2·37	9	1·76	5	1·75	3	1·14	151	33·69
Græme Hall		18	3·08	12	1·23	4	·45	1	·19	7	1·16	5	·32	14	2·87	16	3·48	17	2·86	16	2·91	14	5·05	11	2·97	14	3·09	8	1·64	2	·32	4	·48	163	32·13
Pickerings	71	11	1·55	9	1·15	8	1·73	1	·32	5	1·69	5	·32	12	4·06	16	1·30	14	2·87	17	6·66	12	1·82	13	5·25	12	1·86	15	2·78	6	1·36	7	1·02	166	38·74
Ridgeway		10	3·11	13	3·29	4	1·07	2	·26	12	1·98	5	·78	13	4·48	15	5·95	9	2·59	18	6·38	15	4·83	10	7·21	10	3·78	16	4·45	5	1·08	1	1·13	159	52·40
Lemon Arbour	720	14	3·77	17	3·00	11	1·27	2	·87	10	2·89	9	1·26	13	5·52	14	6·20	14	2·88	17	5·73	12	5·06	11	6·63	11	4·81	10	2·94	7	2·81	9	1·26	181	56·90
Vaucluse	731	18	3·57	17	2·99	13	1·10	1	·34	9	1·52	7	·51	14	4·46	19	6·16	11	2·82	20	5·53	19	1·46	17	5·03	17	1·01	16	2·52	5	·99	7	1·05	216	47·36
Blackmans		18	3·69	21	1·66	11	1·50	5	·91	15	1·14	10	1·10	18	6·15	19	8·12	17	3·60	18	6·23	21	5·06	23	5·98	21	5·13	17	3·74	8	3·19	9	2·10	254	65·93
Buckden		15	3·19	18	3·59	11	1·64	1	·91	14	3·49	6	1·12	13	4·59	18	8·04	13	3·66	19	6·23	20	5·32	18	5·94	17	4·32	14	3·92	8	3·05	7	2·03	215	60·74
Lion Castle		22	1·62	26	4·54	16	2·10	6	1·20	29	4·43	15	1·50	23	6·32	25	7·98	18	4·21	20	5·91	23	6·67	16	6·28	22	4·56	17	1·31	9	1·96	8	1·47	286	68·09
Mt. Wilton		17	3·24	21	4·01	11	2·12	5	·71	15	3·92	13	1·53	18	5·04	20	7·31	18	3·39	17	6·06	19	5·38	18	1·70	16	4·03	14	3·92	6	1·22	6	1·22	237	57·86
Warrens		16	3·19	12	3·21	7	1·04	1	·68	5	2·06	3	·61	14	5·78	13	6·28	15	4·12	11	6·60	11	4·29	10	2·69	13	3·76	9	2·26	3	·82	3	·39	155	48·18
Clifton Hall		15	2·27	17	2·92	10	1·52	8	·75	14	2·66	4	·85	12	1·12	15	6·96	15	3·08	17	6·03	15	3·20	17	6·30	12	3·73	12	2·60	6	1·42	7	1·20	196	49·61
Govt. Industrial School ..		18	2·81	11	1·75	6	·56	1	·43	7	1·32	6	·15	13	3·36	19	3·90	14	2·13	13	2·30	11	1·26	15	2·01	16	2·48	12	1·81	7	·95	6	·88	181	28·73
																																Means		191	49·26

Name of Station.	No of Stations	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
		Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
District "A"														
St. Michael														
Lowlands ...	22	2·32	1·04	·24	1·32	·41	3·49	4.15	2·88	4·69	3·94	3·23	2·49	30·20
District "B"														
Christ Church														
Lowlands ...	18	2·75	·84	·56	2·42	·42	4·52	4·05	3·17	2·29	3·07	2·52	2·61	29·22
St. George														
Highlands ...	10	3·60	1·74	·71	2·30	1·37	5·73	6·88	3·68	5·59	4 66	4·87	4·61	45·74
Lowlands ...	13	3·07	1·10	·42	1·78	·73	4·81	4·80	3·12	3·22	4·53	3·21	3·21	34·00
District "C"														
St. Philip														
Highlands ...	3	2·45	·62	·39	1·78	·99	4·77	5·37	3·02	3·98	2·56	2·95	3·40	32·28
Lowlands ...	22	2·08	·62	·53	1·87	·52	4·35	4·17	2·80	2·68	2 71	2·44	2·70	27·47
St. John														
Highlands ...	15	2·85	1·30	·62	2·95	1·15	5·36	6·01	2·95	5·15	3·67	6·32	3·63	41·96
Lowlands ...	3	1·53	·95	·27	2·08	·74	4·02	4·71	2·41	3·69	2·38	4·52	2·60	29·90
District "D"														
St. Thomas														
Highlands ...	10	3·83	1.96	·77	3·25	1·36	5·19	7·49	3 92	6·13	5·91	5·52	4·14	49·47
Lowlands ...	8	3·20	1·00	·52	1·77	·72	4·48	6·27	2·58	5·62	4·10	4·65	3·53	38·44
St. James														
Highlands ..	2	2·65	1·53	·55	3·10	1·15	4·21	7·55	4·14	5·97	6·03	6·68	3·53	46·89
Lowlands ...	10	2·08	1·09	·41	1·37	·63	3·30	5·15	3·01	5·73	3·52	6·54	2·50	35·33
District "E"														
St. Peter														
Highlands ...	7	2·24	1·75	·31	1·96	1·11	3·51	5·33	3·67	6·54	3·68	6·09	2·94	39·13
Lowlands ...	8	2·06	1·67	·34	1·71	1·05	3·04	6·24	2·57	5·23	3 91	6·93	2·93	37·68
St. Lucy														
Lowlands ...	8	1·33	1·31	·31	1·91	·40	4·06	5·16	2·49	6·28	2·83	5·84	2·26	34·18
District "F"														
St. Joseph														
Highlands ...	6	3·91	1·84	·85	3·54	1·29	4·84	7·93	3·13	6·32	5·46	5·90	4·25	49·26
Lowlands ...	2	3·46	1·81	1·00	3·00	1·12	5·49	10·03	3·58	7·74	5·08	7·02	4·25	53·58
St. Andrew														
Highlands ...	3	2·44	1·32	·22	1·80	1·11	3·17	6·33	4·05	6·59	3·50	6·23	3·07	39·83
Lowlands ...	2	2·23	1·09	·14	1·81	·63	3·24	4·17	4·45	6·34	2·92	6·27	2 51	35·80
Total ..	172	50·08	24·58	8·96	41·72	16·90	81·58	111·79	61·62	99·78	74·46	97·73	61·16	730·36
Average ...		2·64	1·30	·47	2·20	·87	4·30	5·88	3·21	5·25	3·92	5·15	3·22	38·44